

5.06 (76.1) B

The American Museum of Natural History



1869
THE LIBRARY

(76.1)5

THE JOURNAL

OF THE

ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830

LIBRARY

FEB 9 1973

THE AMERICAN MUSEUM
OF NATURAL HISTORY



THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

VOLUME 42

JANUARY 1971

NUMBER 1

EDITOR, PRO TEM.
Robert T. Gudauskas
Auburn University

ARCHIVIST
Clyde H. Cantrell
Auburn University

EDITORIAL BOARD
Lowell Wilson, Chairman
Auburn University

Dan C. Holliman
Birmingham-Southern
College

Ann Everett
Crossville High
School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ARTICLES

Petrography of the Newala Limestone in Northern Shelby County, Alabama David W. Yeager	3
Water Stored in Abandoned Mines as a Mineral Resource in Alabama Reynold Q Shotts	10
Effects of Low Level X-Irradiation on Regenerating Tail Fin of <i>Gambusia affinis</i> Shirley Wilkerson, Paula Beatty, and T. E. Denton	17
Competition Between Doves and Blackbirds for Available Grain in Central Alabama Donald W. Coon	22
Insecticide Residues in Bobwhite Quail Associated with Alabama Soybean Production Sherwood C. McIntyre, Jr., and M. Keith Causey	28
Descriptive Survey of Identified X-Ray Sources Robert M. Wilson	34
The Image of Alabama Samuel H. Himes, Jr.	47
Federal Highway Safety Programs— Organizational Disunity Grant M. Davis	54

Petrography of the Newala Limestone

PETROGRAPHY OF THE NEWALA LIMESTONE IN NORTHERN SHELBY COUNTY, ALABAMA

David W. Yeager
Auburn University
Auburn, Alabama

INTRODUCTION

The purpose of this study was to determine the major carbonate rock types which characterize a subsurface section of the Newala Limestone from the vicinity of the type locality.

The Newala, of Lower Ordovician (Beekmantown) age, was named from exposures in a portion of the Cahaba Valley around Newala, a post office midway between Calera and Montevallo in Shelby County, Alabama. The Newala of the drill site area (Fig. 1) is underlain by the Longview Limestone and overlain by limestone of either the Odenville or Mosheim.

The rock core about which this report is written was drilled in Sec. 15, T. 18 S., R. 1 W., Shelby County, Alabama, during the summer of 1967 by Vulcan Materials Company.

MATERIALS AND METHODS

Standard petrographic techniques of polished slabs, etched surfaces, acetate peels, stained surfaces, thin sections and insoluble residue determinations were employed in this study.

A 200-ft core representing approximately 140 ft of stratigraphic section was split lengthwise by sawing and the cut surfaces were lapped and polished with carborundum grit. The polished surfaces were etched by immersion in 10% HCL for approximately 1 min. Etching brings out much textural detail and enables differentiation among grain types and between grain and matrix constituents.

Acetate peels were made from the etched surfaces by flooding the surface with acetone, pressing acetate film (0.0003 in.) to the wetted surface, peeling the dry acetate, and mounting the acetate film between glass plates. This technique produces a good reproduction of rock texture. The lithologic succession of the core was thoroughly investigated by making peels of each succeeding lithology.

Two stains were used: (1) alizarin red-S which is calcite selective, and (2) potassium ferricyanide which is selective for ferrous ion (4). Alizarin red-S stains calcareous rocks red, while potassium ferricyanide stains ferroan rocks a light blue color. Staining was accomplished by first immersing the rock slab in alizarin red-S and then in potassium ferricyanide. Immersion time varied, but about 30 sec. in alizarin solution was sufficient; immersion in potassium ferricyanide required about two min. for best results.

Selected thin sections were made of portions thought to be best examples of various carbonate rock types.

Insoluble residue determinations were made to cross-check visual estimates of insoluble components. Forty to 50 g samples of the core were crushed and placed in approximately 1 liter of dilute acetic acid for digestion, which required about 36 hr for completion.

RESULTS

The classification and terminology of Folk (2) was used in the rock descriptions of this study.

The major lithologic types found in the Newala were: micrite, pelmicrite, intramicrite, biopelmicrite, intrasparrite, laminated dolomite, non-laminated dolomite, and sparite. These can be grouped into three categories thought to represent *supratidal*, *intertidal*, and *subtidal* environments. Micrite, intrasparrite, intrasparrudite, intramicrite, and pelmicrite were interpreted as intertidal in origin; laminated dolomite as supratidal; and biopelmicrite as subtidal. Syngenetic dolomite and sparite rock types also were identified. A description of each rock type follows.

Micrite was composed almost wholly of microcrystalline calcite with little or no allochemical constituents (Fig. 2). Approximately 40% of the core examined consisted of micrite. This rock type is indicative of a low energy, intertidal environment.

SHELBY COUNTY

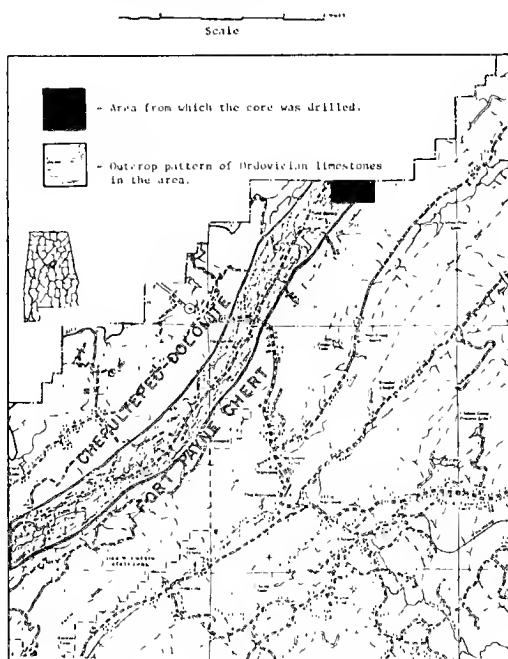


FIGURE 1. Index map showing drill site area Sec. 15, T. 18 S., R. 1 W.

Petrography of the Newala Limestone

Pelmicrite consisted of greater than 10% pelletal material surrounded by a micrite matrix (Fig. 4). Some of the pelmicrite examined contained quartz sand thereby reflecting proximity to a terrigenous source. Pelmicrite constituted approximately 11% of the core. The pellets ranged in size from coarse silt to medium sand. This rock type is also indicative of a low energy environment.

Intramicroite consisted of greater than 25% intraclasts surrounded by a micritic matrix (Fig. 3). Approximately 6% of the core consisted of this rock type. The intraclasts were irregularly rounded and of variable shape. Intramicrite reflects low energy conditions at the site of deposition.

Biopelmicrite consisted of greater than 25% skeletal material surrounded by a micrite matrix (Fig. 5). The primary shell contributors were the high-spined gastropod *Hormotoma* and the low-spined gastropods *Maclurites* and *Esotomaria*.

Biopelmicrite totaled approximately 10% of the core examined. Biopelmicrite is indicative of a subtidal environment of low turbulence.

Intrasparite consisted of greater than 25% intraclasts surrounded by sparry calcite cement (Fig. 6). Approximately 5% of the core was intrasparite. *Intrasparrudite* (Fig. 7) consisted mostly of intraclasts that were larger than 1 mm. Intrasparrudite constituted about 10% of the core.

Intraclastic rocks are indicative of intermittent turbulence and could possibly represent storm conditions in the intertidal zone.

Equigranular dolarenite displayed obscure laminations. This dolomite is interpreted as a recrystallized dolomite following penecontemporaneous dolomitization of lime-mud under supratidal conditions. Laminated dolomite (Fig. 8) constituted about 9% of the core.

Non-laminated dolomite occurs as a replacement of the calcite in lime-muds, pellets, and veins. Its grain size varied from that of a dolosiltite to dolorudite apparently determined by the original crystal size. It was more localized in its occurrence and when pervasively present it was accompanied by a vuggy porosity (Fig. 9).

Sparite. Coarsely crystalline fracture-fillings of sparry calcite occurred in thicknesses of less than an in. to more than 1 ft. Its mineralization is thought to be attributable to calcium-carbonate rich ground water (Fig. 10).

CONCLUSIONS

In summary, it is believed that the Newala carbonate sediments accumulated on a broad shelf covered by an epeiric sea during Early Ordovician time. The depositional framework of lime-muds in ancient epeiric seas is described by Irwin (3) and is not treated in this paper.

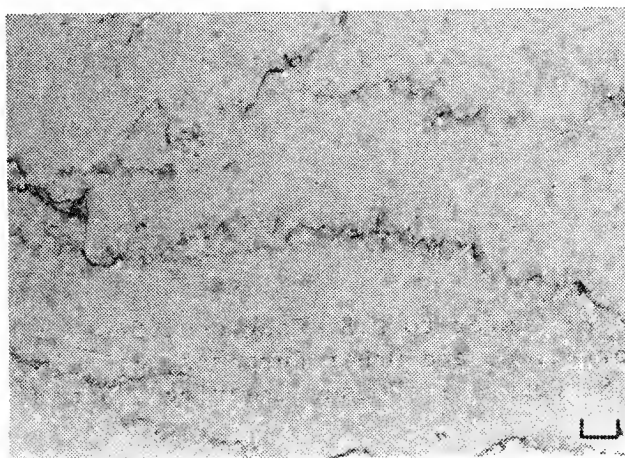


FIGURE 2. Micrite, negative peel print showing stylolites; scale lines, 1 mm apart.

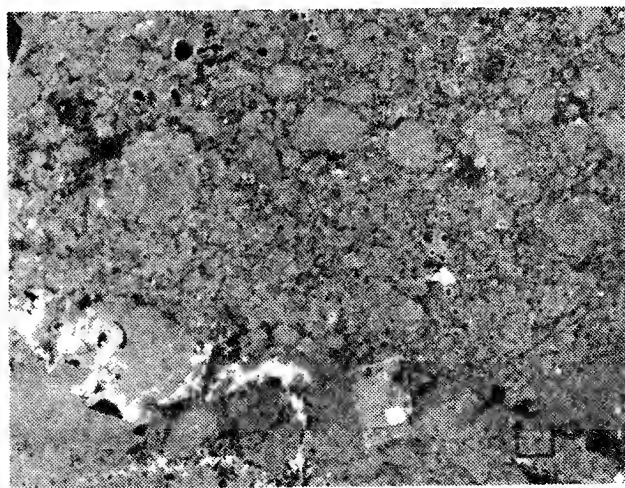


FIGURE 3. Intramicrite, negative peel print; scale lines, 1 mm apart.

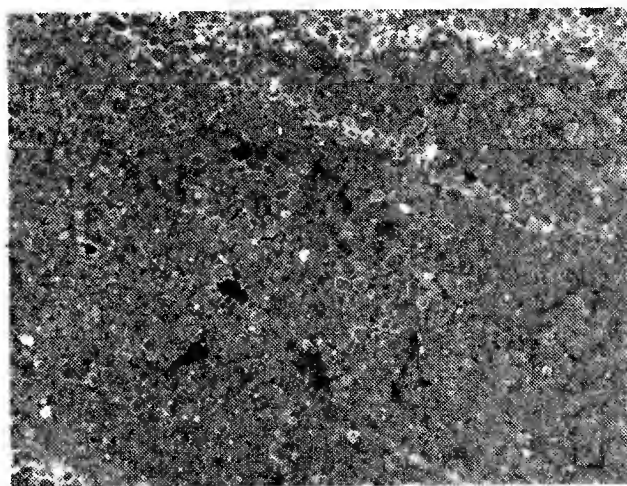


FIGURE 4. Pelmicrite, large, dark-colored grains are well-rounded medium sand-size quartz, (negative peel print); scale lines, 1 mm apart.

Petrography of the Newala Limestone

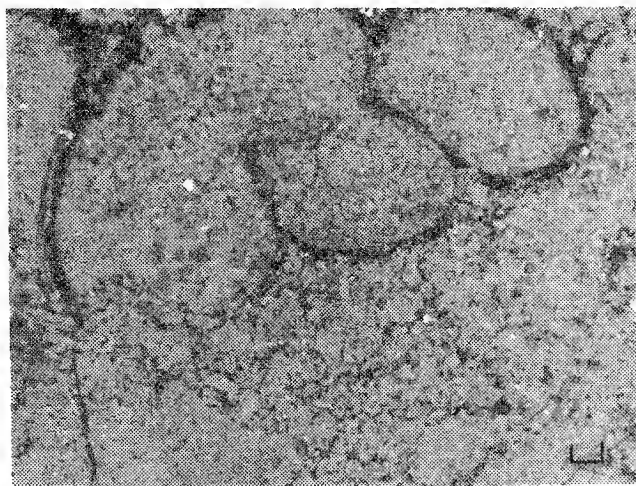


FIGURE 5. Biopelmicrite, majority of identifiable fossils are high-spired gastropods. Cast is filled with pelmicrite (negative peel print); scale lines, 1 mm apart.

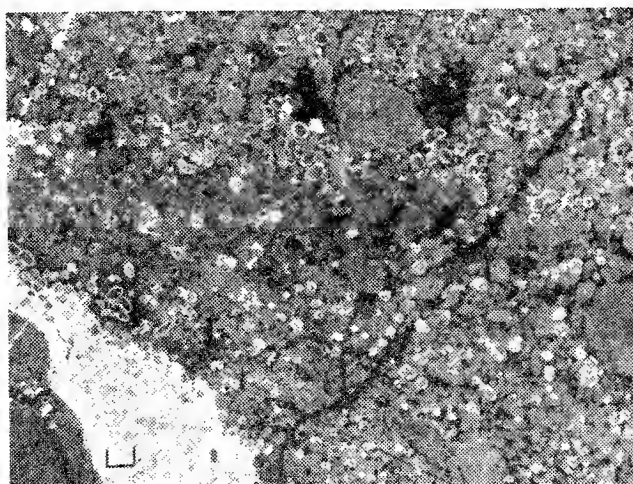


FIGURE 6. Intrasparrite(negative peel print); scale lines, 1 mm apart.

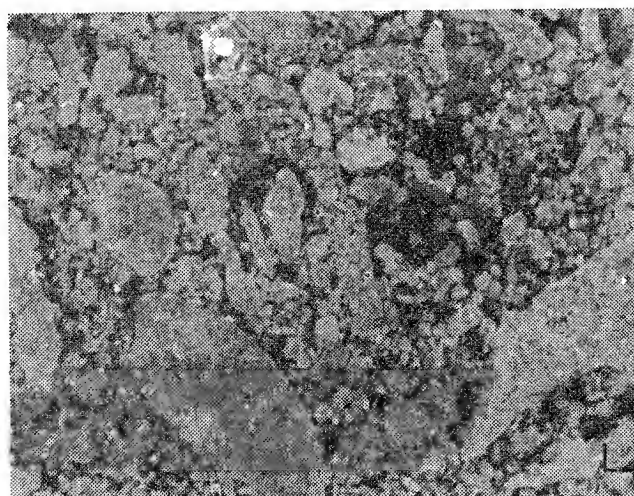


FIGURE 7. Intrasparrudite (negative peel print); scale lines, 1 mm apart.



FIGURE 8. Laminated dolomite, possibly penecontemporaneous (negative peel print); scale lines, 1 mm apart.

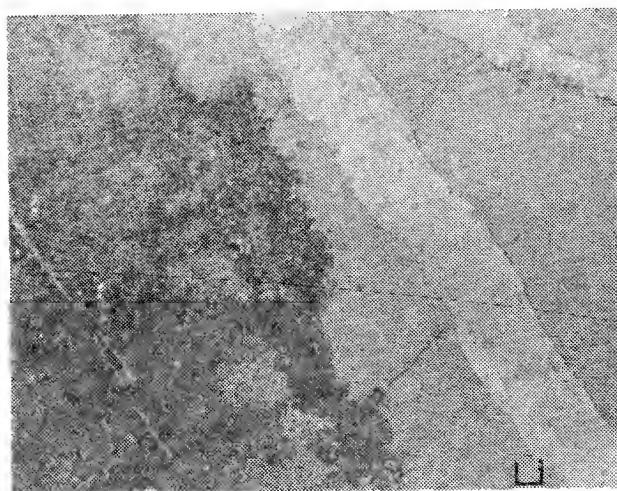


FIGURE 9. Non-laminated dolomite, cut-across by a calcite vein (negative peel print); scale lines, 1 mm apart.

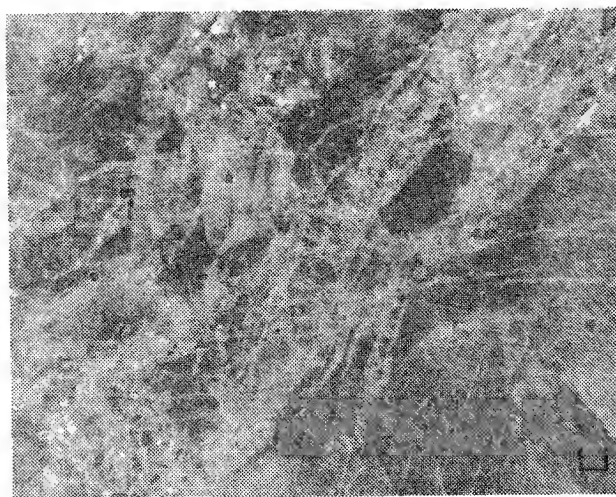


FIGURE 10. Sparite, coarsely crystalline sparry calcite (negative peel print); scale lines 1 mm apart.

Petrography of the Newala Limestone

The major depositional environment represented is intertidal. Biogenic deposits are thought to represent subtidal conditions, and laminated, non-fossiliferous dolomites are thought to represent supratidal conditions.

The waters were shallow, warm, usually calm, intermittently agitated, and of variable salinity.

ACKNOWLEDGMENTS

I would like to thank Mr. Ronald S. Taylor for his invaluable assistance during this investigation. Also I wish to thank Mr. Edward Simonds, Mr. R. W. Owen and Mrs. Nancy Roach for their helpful discussion and criticism of this paper.

LITERATURE CITED

1. Beales, F. W. 1958. Ancient sediments of the Bahaman type. Amer. Assoc. Petroleum Geologists Bull. 42:1845-1880.
2. Folk, Robert L. 1965. Petrology of sedimentary rocks. pp. 141-159.
3. Irwin, M. L. 1965. General theory of epeiric clear water sedimentation. Amer. Assoc. Petroleum Geol. Bull. 49:445-459.
4. Katz, A. and G. M. Friedman. 1965. The preparation of stained acetate peels for the study of carbonate rocks. J. Sed. Pet. 30.

WATER STORED IN ABANDONED MINES AS A
MINERAL RESOURCE IN ALABAMA

Reynold Q. Shotts
University of Alabama

AVAILABLE STORED WATER

Underground mines, penetrating well below the water table, quickly fill with water when abandoned. Ordinarily, these natural cisterns are not thought of as sources of industrial water. Under special circumstances, if chemically acceptable, they might become valuable sources.

Figure 1 shows an idealized cross section of the strata in the Belle Ellen Syncline near West Blocton, Bibb Co., Alabama. Figures 2, 3, and 4 are maps showing the location of the syncline, other structural features, the outcrop lines of the three principal coal beds underlying the basin, and the mined-out areas on the three beds (2).

The Belle Ellen synclinal axis plunges southwestwardly so that all mines opened on the outcrop dip toward the axis and no beds reappear at the surface except on the opposite side of the syncline. With the exception of physically connected works, there is little chance for up-dip mines to drain into those farther down the syncline. Each mine is a trap for a large volume of water, once it is filled, and few of them drain, even partly, into surface streams.

Table 1 shows areas mined, estimated average coalbed thicknesses, and gal. of water held in the principal mines on each of the three coalbeds. Coal recovery is assumed to have been 50%. Estimated total tonnage of coal mined from each mine and bed, in Bibb County (4), is also shown.

Mines of the Thompson bed are the really large reservoirs in the Blocton-Piper area (Table 1). The Thompson bed is the upper, thickest and lowest in sulfur content of the beds mined. The 7.6 billion gal. of water stored in all the mines are equivalent to a lake averaging 25 ft in depth over 934 A. Twenty-five percent of the water is in the Piper area and 62% is in mines on the Thompson coalbed.

Surface water drains into most, or all, the mines to augment the interstitial ground water. Channels of access are: (1) small streams diverted into mine openings. In the SW 1/4 of Sec. 9, T22S, R5W, a small permanent branch of Big Ugly Creek enters an opening on the Thompson coalbed. Although not directly observed by the author, it is said that this and other water drains out of the old mine works and into Big Ugly Creek, about one mile to the southeast, probably in Sec. 16, on the other side of the syncline.

(2) Cracks to the surface from caved works undoubtedly exist, particularly near the outcrop where overburden is shallow. Both ground water and runoff can enter the works through such cracks.

Water Stored in Abandoned Mines

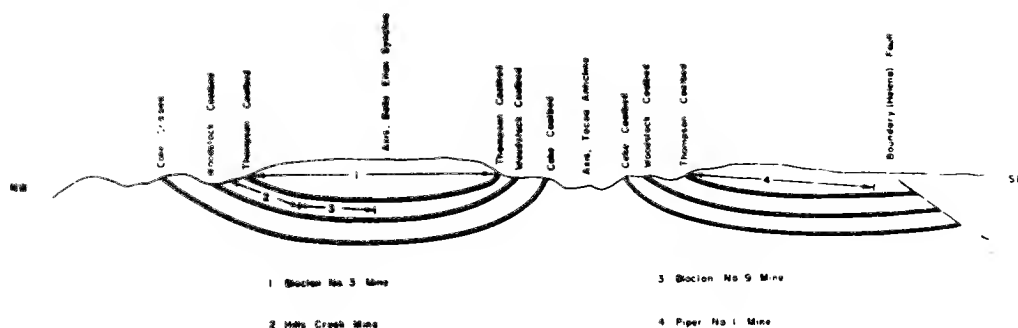


FIGURE 1. Crossection of Belle Ellen syncline and Tocoa anticline showing structure and location of some coal mines (section AB, Figs. 2-4).

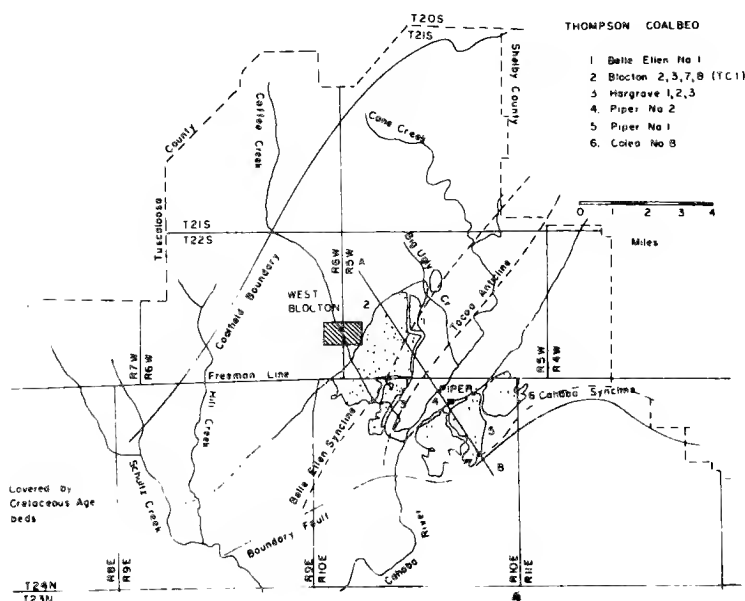


FIGURE 2. Map of the southern end of the Cahaba Coalfield showing structural axes, outcrop of the Thompson Coalbed and the location of water-filled mines on that bed.

TABLE 1. Estimated volumes of stored water in named mines and estimated coal production, mines and district.

Bed	Mine	Area		Bed thickness feet ⁸	Volume of water ¹⁰		Coal production	
		ft ²	mi ²		ft ³	gal.	to 1968 ¹¹	
Coke	Belle Ellen No. 2 ¹	34,771,330	1.24725	2.50	43,464,170	325,111,990	2,403,000	
	Belle Ellen No. 8	15,865,040	0.56908	2.50	19,831,300	148,338,120	1,024,000	
			1.81633		63,295,470	473,450,110	4,000,000	
Woodstock	Belle Ellen No. 5	30,057,380	1.07816	2.67	40,126,660	300,147,420	2,000,000 ¹²	
	Hills Creek	83,593,380	2.99850	2.67	111,597,160	834,746,760	5,364,000	
	Blocton No. 9	25,485,600	0.91417	3.00	38,228,400	285,948,430	2,700,000	
	Blocton No. 10	21,927,200	0.78653	3.33	36,508,790	273,085,750	1,870,000	
	Red Eagle	5,971,000	0.21418	3.50	10,449,250	78,160,390	463,000	
	Lucille ³	17,182,850	0.61635	3.50 ⁹	30,069,990	224,923,530	1,743,000	
	Hill Creek Shaft ⁴	2,260,660	0.08109	3.50	3,956,160	29,592,080	---	
	Braehgad	5,525,220	0.19819	3.00	8,287,830	61,992,970	425,000	
	Dixie ⁵	13,827,690	0.49600	3.50	48,396,920	362,009,000	1,315,000	
			7.38317		327,621,160	2,450,605,330	17,009,000	
					31,441,630	235,183,390	2,046,000	
Thompson	Belle Ellen #1	10,786,150	0.38690	5.83				
	Blocton ⁶ (TCL) #2,							
	3, 7, 8	100,135,530	3.61339	5.83	291,895,070	2,183,375,120	10,929,000	
	Hargrove 1, 2, 3 ⁷	19,737,910	0.70880	5.00	49,344,780	369,098,950	1,735,000	
	Piper #1	39,941,380	1.43270	5.00	99,853,450	746,903,810	2,760,000	
	Piper #2	28,739,560	1.03089	4.50	64,664,010	483,686,790	4,280,000	
	Coleanor	35,379,640	1.26907	4.50	88,449,100	661,599,270	3,300,000 ¹³	
			8.44175		625,648,040	4,679,847,330	31,177,000	
			17.64125		1,016,564,670	7,603,902,770	52,186,000	

Water Stored in Abandoned Mines

- ¹Also called Youngblood mine.
- ²Includes Klondike mine and numerous small mines all shown on maps to be physically connected to the Hills Creek mine.
- ³Also called Red Feather mine.
- ⁴Described by Butts (2); evidently the largest of several mines shown on coal company maps to northwest of Lucille mine.
- ⁵Also called Moffatt mine.
- ⁶Tenn. Coal, Iron and R. R. Co. mines apparently physically connected.
- ⁷Physically connected; Tico mine in the same area apparently connected to Hargrove mines or to Blocton 2,3,7,8.
- ⁸From State Mine Inspectors reports, Ala. Dept. Ind. Rel., 1940-; Ala. State Mine Insp., 1893-1904 and 1904-1939.
- ⁹No figure available. Assumed same as Lucille mine but Butts (2) implies greater thickness.
- ¹⁰Assuming average coal recovery of 50%.
- ¹¹If account taken of small mines, strip mining (about 1,000,000 tons to 1968) and unrecorded production, bed figures for the Blocton-Piper area probably are about: Coke or Youngblood, 4,250,000 tons; Woodstock, 18,000,000 tons; Thompson, 32,000,000 tons.
- ¹²Includes Klondyke mine; all productions are recorded tonnages plus some interpolations in years when figures were not available, thus figures may be minima.
- ¹³Found by subtracting production of Gearnsey mine from total Thompson bed estimate of Shotts (4). District production figures include small mines and stripping and this, are larger than the sum of productions from mines named.

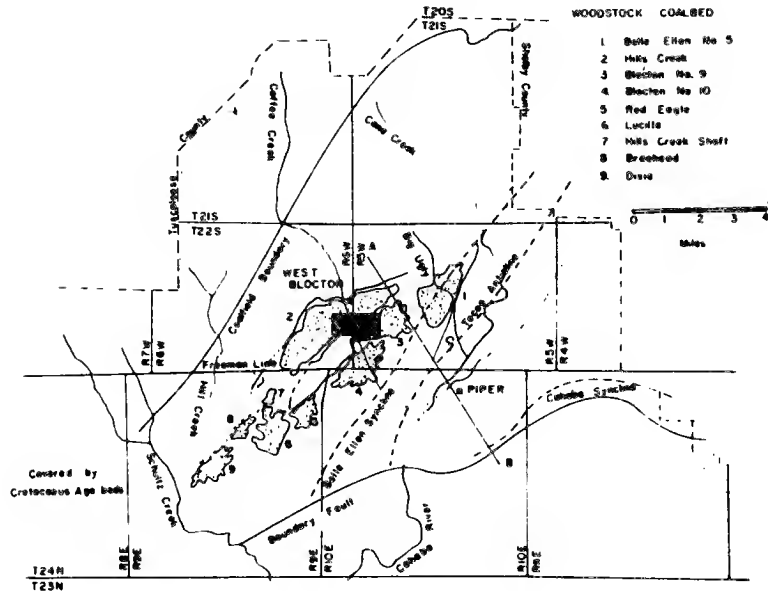


FIGURE 3. Map of the southern end of the Cahaba Coalfield showing structural axes, outcrop of the Woodstock Coalbed and the location of water-filled mines on that bed.

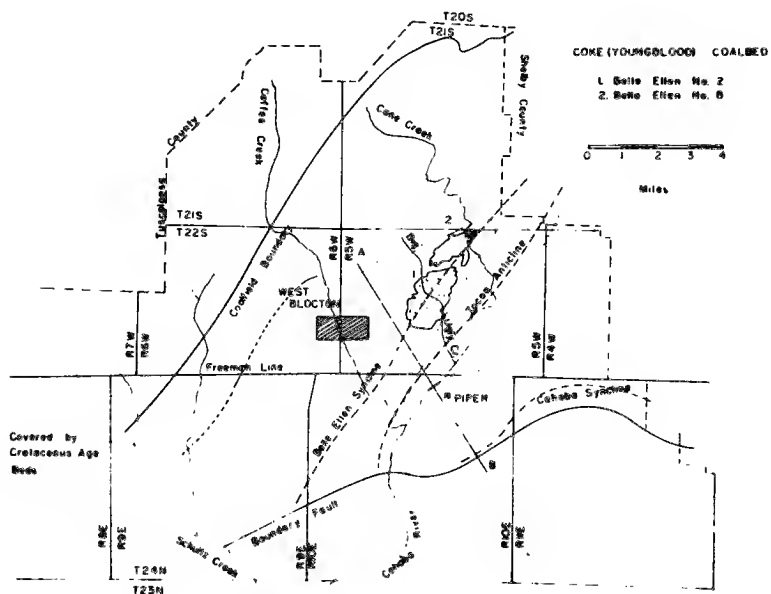


FIGURE 4. Map of the southern end of the Cahaba Coalfield showing structural axes, outcrop of the Coke Coalbed and the location of water-filled mines on that bed.

Water Stored in Abandoned Mines

(3) The syncline is rapidly being rimmed by strip pits. These pits break into old rooms and surface water drains into abandoned works from them. In the NW 1/4 of the SW 1/4, Sec. 10, T24N, R11E, the dip of the Thompson coalbed and its outcrop elevation are such that water is flowing out of a caved mine opening in a strip pit and into the Cahaba River, only a few hundred yards away. This is a low elevation point. To the eastward are several higher openings through which water can flow into the mine.

The only coal washing plant in Bibb County has used water from the abandoned Klondyke mine (Sec. 18, T21S, R5W) for years and plans to continue to do so in the plant that has recently been completed. One test on this water showed a pH of 6.¹ Some pumping of water from abandoned Blocton No. 10 is being done and test results from this operation may reveal the rate at which the mine refills after being partially pumped out.

QUALITY OF STORED WATER

That vast quantities of water are stored in mines and that it is rapidly replaced when pumped are evident. However, the quality of water obtained from coal mines is questionable. Because of the ease of oxidation of iron pyrite which is invariably associated with coal, coal mine water is usually acid and contains small concentrations of iron salts. Iron pyrite and ferrous carbonate (siderite) may also be present in the broken roof strata of the caved works. The minerals may be partly oxidized or reduced to soluble form and dissolved in mine water.

Before any specific industrial use of the stored water in the West Blocton or Piper areas is contemplated, it should be carefully analyzed. Quality of the water that will refill the mine will also be important. Comparison of analyses of water from Thompson bed mines like Piper No. 2 and Blocton No. 1, that have in and out drainage, with those like Hargrove No. 1 and 2, that may not have outward drainage, should yield valuable information in this regard.

If water from the abandoned mines of the Blocton basin is acid, it probably will be the minimum to be expected from any coal mine. As Table 2 shows, average sulfur and pyritic sulfur is about as low as can be found in this country. The Thompson bed is particularly low in sulfur. Analyses as low as 0.3 and 0.4% total sulfur, have been reported for this bed.

TABLE 2. Maximum, average and minimum sulfur contents of channel samples and of washed and/or sized samples of Coke, Woodstock and Thompson coals analyzed by the U. S. Bureau of Mines (1,3).

	<u>Coke</u>		<u>Woodstock</u>		<u>Thompson</u>	
	Channel	Washed	Channel	Washed	Channel	Washed
Max.	1.5	---	1.6	1.3	0.9	0.9
Avg.	1.28	---	1.20	1.12	0.56	0.6
Min.	1.2	---	1.0	0.5	0.3	0.5

¹Personal communication; R. J. and C. B. Blair, Black Diamond Coal Mining Co., Birmingham, Alabama.

Where Piper No. 2 drains into the river in the NW 1/4 of SW 1/4, Sec. 10 T24, R10E, the water is heavily loaded with iron. A red scum covers all the channel to the river, and the water has a chalybeate taste. However, the water may not be strongly acid from oxidation of sulfur. The iron could have been reduced by rotting mine timbers and other organic matter from both bed and enclosing strata to ferrous form and oxidized to ferric oxide on reaching the air. Thus its source may have been siderite, oxides and other iron minerals in the coal and roof strata, as well as iron pyrite. A thorough study of the dissolved impurities in the water from the mines should give exact answers to the question of water quality. Certainly, the quality is good enough for coal washing plants and there may be other possibilities for industries with only moderately demanding water quality standards.

LITERATURE CITED

1. Bureau of Mines Bulletin 498, 516, 1951; Technical paper 611, 1940; Report of Invest. 3449, 1939; 4972, 1953; 5085, 1955; 5221, 1956; 5401, 1958; 5489, 1959; 6461, 1964; and 6622, 1964.
2. Butts, Charles. 1911. The southern part of the Cahaba coalfield, Alabama. *In* Contributions to Economic Geology, 1909. U. S. Geol. Survey Bull. 431:89-146.
3. Butts, Charles. 1925. Analyses of Alabama coals. Alabama Geol. Survey Bull. 31.
4. Shotts, Reynold Q. 1960. Private report on coal reserves in Coke, Woodstock and Thompson Coalbeds, Bibb Co. Mid-Continent Coal and Coke Co., Chicago, Illinois.

Effects of Low Level X-irradiation

EFFECTS OF LOW LEVEL X-IRRADIATION ON REGENERATING TAIL FIN OF *Gambusia affinis*

Shirley Wilkerson, Paula Beatty, and T. E. Denton
Department of Biology
Samford University, Birmingham, Alabama

INTRODUCTION

The teleostei, which have fins composed of ossified plates which articulate distally with rays of dermal bone, have proven to be excellent organisms for experiments in regeneration (5). Relatively few fishes have been studied in terms of fin regeneration, especially when the number and diversity of fishes capable of regeneration are considered. Numerous tropical fishes and various species of *Fundulus* have been the most widely used experimental organisms for regenerative studies (1,6,7,8).

Fin rays grow by addition. Since ray segments already formed cannot elongate, fin rays add to themselves terminally (5). Fins possess a generative zone along the outer margins which provide for unlimited growth commensurate with increasing body size. Each fin ray is segmented throughout its length and branches dichotomously as it elongates. When one of these fins is amputated, and healing has closed the wound, the epidermis becomes thickened over the stump. A blastema develops that is composed of undifferentiated cells, possibly derived from loose connective tissue, and osteoblasts associated with the ray stumps themselves. The osteoblasts aggregate at the ends of the rays and later become associated with the epidermis overlying the blastema. New fin rays develop initially along two sides of the elongating regenerate and secondarily become continuous with old ray stumps (6). As the regenerative process proceeds, the newly forming rays become segmented at regular intervals.

Since the classical studies of Butler (2), in which newts were used to study the regenerative capacity of limbs treated with X-rays, little has been reported concerning the effects of X-irradiation of regenerating tissues of cold-blooded organisms other than with the newt. The primary objectives of this study were to determine the effects of low level X-irradiation on the regenerative growth rate of fin tissue in *Gambusia affinis* (Baird and Girard) and to examine some of the factors affecting the rate of fin regeneration.

MATERIALS AND METHODS

Gambusia affinis was collected by seine and maintained in well-aerated aquaria on a regulated diet of Tetramin. A specified number of organisms, constituting the experimental group, was exposed to 500 R of X-irradiation after first amputating the end of the caudal fin. The X-rays were beamed at a setting of 6 m amp and 82 kV for 126 sec. at a distance of 7 in. Routinely, five males and five females were irradiated simultaneously. Similar groups constituting the controls were not irradiated.

The growth rate of regenerating fin was measured daily with an ocular micrometer inserted into the eyepiece of a dissecting microscope.

Each organism was weighed and the weights recorded prior to irradiation treatment.

Chromosomes were enumerated according to the technique suggested by Denton and Howell (3). In both the control and experimental groups fin epithelia were treated with hypotonic deionized water for 1 hr before fixing in methanol-glacial acetic acid (3:1) for 15 min. The fixed cells were deposited on a clean slide, air dried for at least 10 min., then stained for 15 min. in 2% aceto-orcein under a clean coverslip. The preparation was blotted between filter paper and the coverslip ringed with permount to prevent drying. In some cases, the organism was allowed to swim around in 0.05% colchicine for 3 hr before processing the tissue in an attempt to induce more metaphase figures. Chromosomes were observed and photographed with a Leitz Ortholux research microscope equipped with a 4 x 5 in. camera head. Figures were photographed under oil using high contrast film.

RESULTS AND DISCUSSION

X-irradiation had an inhibitory effect on regenerative growth of caudal fin tissue of *G. affinis* (Fig. 1). On the average, the regenerative growth rate after 24 hr was decreased 80-90% when healthy organisms were exposed to a total of 500 R of X-irradiation over a period of 126 sec. In the absence of X-ray treatment, the greatest amount of growth was measured during the first 24 hr. After that period, the daily growth rate stabilized at approximately 0.12 mm/24 hr. Also, regenerative growth was faster in the control females than in the control males, particularly during the first 24 hr. Since females are typically larger than males, the possibility that these differences were due to body weight and not sex differences was tested. The following coefficients of correlations were determined to establish relationships between body weight and rates of regenerative growth for both experimental and control groups:

non-irradiated fishes consisting of 16 males and 15 females..0.295
irradiated fishes consisting of 16 males and 15 females.....-0.569

The value for the non-irradiated group indicated that body weight was not normally related to rate of fin regeneration. In the irradiated group, the negative correlation suggests a tendency for smaller fishes to recover faster from the effects of x-rays than larger fishes. The reason(s) for this reversal in growth rate when irradiated is not clear. Since age and other factors could possibly be interrelated with this correlation, additional data are needed before valid interpretations can be made.

With a lower level of radiation, growth inhibition lasted for 72 hr. Normal growth was attained after 120 hr. During inhibition, cell division in the thin layers of epidermis and blastema was apparently slowed as a result of interference at some point in the cell cycle. It is thought that this interference occurred during the G₁ stage of interphase. There are a number of reasons for making this assumption. If cellular damage was induced during the M phase, visible alterations should have been observed in the nucleus. Nuclear aberrations, particularly chromosomal,

Effects of Low Level X-irradiation

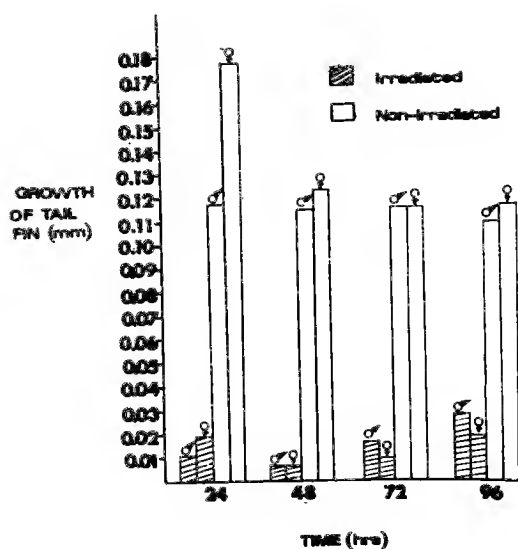


FIGURE 1. Comparison of regenerative rates of caudal fins in irradiated and non-irradiated *Gambusia*.

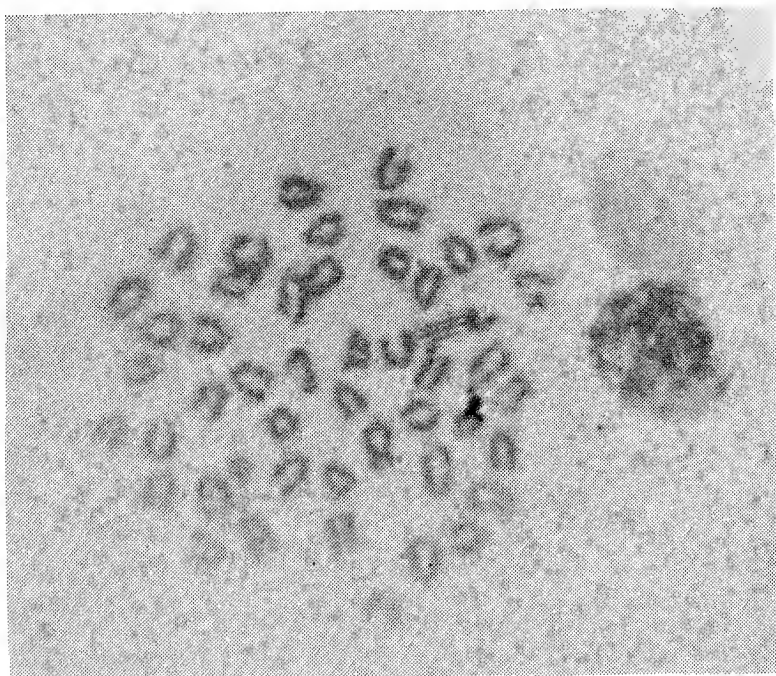


FIGURE 2. Typical chromosome metaphase spread from regenerating tail fin epithelia of *Gambusia affinis* after exposure to low level X-irradiation. $2N=48$, 3000X.

were not found. Metaphase spreads in the irradiated cells were similar to those in the control group (Fig. 2). If interference was produced in the post-synthetic G₂ phase, a burst of tetraploid cells would be expected to form during the recovery period (4). This was not the case. Tissue culture studies also suggested that radiation doses exceeding 500 roentgens were required to inhibit DNA synthesis (4). The dividing cells within the protected epidermis and blastema of the caudal fin would presumably require more than the short term exposure of 500 R to inhibit the S phase within these cells. Therefore, the synthesis stage is not suspected as the source of inhibition. Only the G₁ stage remains. If this is indeed where interference occurs, then the S phase would be prevented and visible signs of division would be reduced for an interval of time terminating with recovery of the G₁ stage. This would also explain the decrease in division figures in the irradiated fin tissue. The few figures that were found could have originated from DNA replications prior to radiation damage of the G₁ phase.

In summary, the following points appear significant to caudal fin regeneration in *Gambusia*:

1. Low level X-irradiation markedly decreases the rate of caudal fin regeneration.
2. In non-irradiated fishes, the rate of fin regeneration is independent of body weight and is greater in females than males.
3. After radiation exposure, there is a tendency for smaller fishes to regenerate tissue faster than larger fishes.
4. Chromosomes from fin epithelia show no damage from low level X-ray exposure. The decrease in cell division is attributed to interference at the G₁ stage of the cell cycle.

ACKNOWLEDGMENT

The authors wish to thank the Samford Research Committee for supporting this study.

LITERATURE CITED

1. Birnie, S. H. 1935. Regeneration of the tail-fins of *Fundulus* embryos. Biol. Bull. 66:316.
2. Butler, E. G. 1935. Studies on limb regeneration in X-rayed *Amblystoma* larvae. Anat. Record 62:295.
3. Denton, Thomas E. and William M. Howell. 1969. A technique for obtaining chromosomes from the scale epithelium of teleost fishes. Copeia. 2:392.
4. Firket, H. 1965. Cell division. In Cells and tissues in culture. Ed., E. N. Willmer Academic Press. Vol. I.

Effects of Low Level X-irradiation

5. Goss, Richard J. 1969. Principles of regeneration. Academic Press, N. Y.
6. Goss, Richard J. and M. W. Stagg. 1957. The regeneration of fins and fin rays in *Fundulus heteroclitus*. J. Exptl. Zool. 136:457.
7. Nabrit, S. M. 1931. The role of the basal plate in regeneration in the tail-fins of fishes (*Fundulus* and *Carassius*). Biol. Bull. 60:60.
8. Scott, G. G. 1909. Regeneration in *Fundulus* and its relation to the size of the fish. Biol. Bull. 17:343.

COMPETITION BETWEEN DOVES AND BLACKBIRDS
FOR AVAILABLE GRAIN IN CENTRAL ALABAMA

Donald W. Coon
Department of Wildlife Science
Texas A&M University, College Station

The seasonal kill of mourning doves, *Zenaidura macroura*, has risen sharply from an estimated 15 million birds in 1949 to nearly 30 million in 1961 (4). It is now a legal game bird in 30 states. The dove's adaptability to present land use is indicated by its wide distribution, increasing numbers, and nesting range which includes most of North America. Many people feel that there has also been an increase in the number of blackbirds wintering in the southern states during the past several years (2). This increase, and concomitant loss of agricultural crops, has caused many complaints. Some of the complainants fear a possible detrimental competition between doves and blackbirds.

According to Keeler (1), blackbird species found to be most numerous in the southeastern United States during the winter season were: (1) red-winged blackbird, *Agelaius phoeniceus*; (2) common grackle, *Quiscalus quiscula*; (3) brown-headed cowbird, *Molothrus ater*; plus the starling, *Sturnis vulgaris*. Meanley and Webb (2) located 10 new major roosts with over one million birds each in 1966, bringing the total number of major blackbird wintering roosts east of the Mississippi River to 175 and an estimated population of almost one-half billion birds. Keeler (1) stated that possibly only one-half of the winter blackbird population in Alabama were using established roost sites. If the same situation is true in other states supporting winter populations of these birds, the grand total would certainly be much larger than the one-half billion estimated by Meanley and Webb (2).

Mourning doves feed in sparse cover and are strictly vegetarians, with seeds and plant material comprising over 99% of their diet (3). Under normal conditions, only food lying on top of the ground is eaten by doves. Doves customarily feed twice a day, once in the early morning, then again in the afternoon. The timing and duration of the feeding periods may be influenced by adverse weather conditions.

In 1965, the Alabama Cooperative Wildlife Research Unit initiated a study of the extent of competition between doves and blackbirds for available food during the winter season.

MATERIALS AND METHODS

Twenty-six fields ranging in size from 15 to 150 acres and planted primarily to attract doves for hunting were selected across east-central Alabama. Fifteen were planted with corn, seven contained browntop millet, and the remaining four were planted in sorghum. The amount of grain available in each field, estimated in pounds per acre, was checked weekly from time of harvest until the field was flooded or plowed under, or the grain was exhausted by usage.

Competition Between Doves and Blackbirds for Grain

There were two major blackbird roost sites approximately 60 miles apart in the study area. The study fields were situated from one to 30 miles from the nearest roost. The two roosts were used by a large percentage of the birds observed feeding in the study fields. This was determined by following the feeding birds to their roosting sites.

"Available grain" was defined as that grain which could be utilized as food by both doves and blackbirds. This was measured in the corn and sorghum fields by counting the number of grains on 10 circular mil-acre plots per field that were selected at random. Blackbirds were noted searching below ground level for seeds. Doves do not, therefore it was necessary to modify the soil-borer sampling method of Ripley and Perkins (5) for use in this study. A commercial onion-chopper with four vertical blades was modified into a scoop. When the blades were turned by the central rod all seeds, dirt, and debris were collected to a depth of approximately $1/8$ to $1/4$ in., depending on the soil texture and compactness. The diam. of the circle covered by the blades was 3 in. Ten randomly selected mil-acre plots were used per field, and from each of these, eight subsamples were taken using the modified onion-chopper. Samples taken in the millet fields were screened in the laboratory and the seeds counted. This gave an average figure for each mil-acre sample that could be expanded for later computations.

Both feeding doves and blackbirds were collected from the study fields and at random throughout the study area. The pro-ventriculus of the birds was examined for recently eaten food. Both the gizzard and pro-ventriculus were examined from those birds collected outside the study fields. Food habits analysis methods employed in this project were similar to those used by Stickney (6).

RESULTS AND DISCUSSION

In early fall, large flocks of doves gathered in fields of preferred grains as they became available. As the season progressed, the large flocks tended to break up. The doves were then seen in much smaller numbers feeding in diversified situations such as feed lots, weed patches, and small grain fields.

During late fall and early winter, large flocks of blackbirds fed from field to field throughout most of the day. The distance from the roost to the fields utilized increased until midday. In the afternoon the birds usually turned toward the roost, stopping intermittently to feed. As darkness neared, the flocks gathered into long streams or flyways and returned to the roost. Large fields, cattle pens, and pig pens served as last-stop feeding areas. A high percentage of the birds in any one flyway would drop down to these areas, feed quickly and move on.

Observations showed that only preferred foods such as millet and cracked corn were taken by the large early-winter flocks from the study fields surrounding the roosts. As the winter season progressed and preferred foods became more difficult to find, the flocks tended to break up into smaller units. These units returned to fields previously gleaned of preferred foods and apparently ate whatever was available.

Doves, though exhibiting a generalized flocking behavior, remained apart from each other within a field when feeding. Doves were found in loosely formed flocks when a preferred food was concentrated within a relatively small area. Blackbirds congregated into large flocks during the early winter and fed from field to field. Each blackbird flock fed within a small area and the birds acted more as a unit than as individuals.

Blackbirds were observed leaving the winter roosts each morning. The departure time varied with weather conditions and light intensity. The distance traveled to the feeding grounds varied from 5-25 miles and was dependent upon weather conditions. The longest feeding flights were recorded on clear, calm days. Heavy cloud cover, precipitation, and low temperatures inhibited long flights. During periods of harsh weather, the birds left the roost later, traveled shorter distances, and returned earlier.

A crop analysis of doves collected while feeding in the study fields revealed that these birds invariably were utilizing the grain crop present in that field. Analysis of crop contents of doves collected at random in Lee County, Alabama, after the breakup of the large flocks in winter showed that whole kernel corn and grain sorghum were the first and second items, respectively, taken in order of importance on a percentage volume basis (Table 1).

TABLE 1. Crop contents of blackbirds and doves collected during the 1967-68 winter season in Lee County, Alabama

	Blackbirds		Doves	
	Volume %	Frequency %	Volume %	Frequency %
<i>Zea mays</i>	71.9	88.5	57.0	82.6
<i>Panicum ramosum</i>	6.4	9.2	--	--
<i>Xanthium</i> sp.	7.8	7.6	--	--
<i>Panicum</i> sp.	5.8	33.6	--	--
<i>Sorghum bicolor</i>	tr.	4.3	30.8	13.0
<i>Eleusine indica</i>	tr.	6.0	--	--
<i>Phytolacca americana</i>	--	--	5.6	21.7
<i>Glycine max</i>	--	--	3.4	13.0
Animal matter	4.1*	21.0	--	--

* Starlings contained 36% animal matter.

Competition Between Doves and Blackbirds for Grain

Cracked corn was found to be the most important food for all species of blackbirds during this period, although starling crops contained 36% animal matter. Other species appeared to take animal matter incidentally to grain and grass seeds.

Doves and small numbers of blackbirds feeding side by side were noted frequently during the fall. As the winter flocks of blackbirds began to arrive in the study area, occurrence of doves feeding in close proximity to blackbirds was noted with less frequency. Large blackbird flocks disturbed doves, possibly because of the constant motion associated with the large flocks of blackbirds. Hunters and landowners complained that flocks of blackbirds would move into a field and force the doves to leave. Several examples of this behavior were observed, but in each either the fields were small, 1-5 acres, or flocks of 10-20 thousand blackbirds were present.

In 50-100 acre fields of harvested grain, flocks of blackbirds often entered at one end of the field, then "leap-frogged" across the field and promptly moved on to another area. Doves in the larger fields simply left the immediate vicinity of the incoming blackbird flock and flew to another section of the field to resume feeding. Small fields grown for the primary purpose of drawing doves to a "shoot" were particularly vulnerable to this type of competition, as large quantities of preferred food were available in a concentrated area.

In some corn fields in the study area, livestock fed on waste grain and scattered cracked corn over the fields. Blackbirds were frequently seen in this type of field. The undigested particles of corn that passed through the livestock were of particular importance, and all manure heaps were gleaned thoroughly by blackbirds. As winter flocks began to arrive, the numbers of blackbirds using these fields increased rapidly. Specimens collected in corn fields with livestock had invariably been feeding heavily. This was in sharp contrast to those blackbirds found in corn fields without livestock.

The week of 23 November 1967, marked the beginning of the mass fall migration of blackbirds into the study area. Both doves and small groups of blackbirds were seen regularly in the corn fields with livestock until the arrival of the migratory flocks. Few doves were seen in these fields after the first week of heavy blackbird migration into the study area. In contrast, large numbers of doves were seen frequently in cornfields with livestock throughout the winter, but appeared only occasionally in those fields without livestock.

Five of the seven millet fields were depleted of available grain before the arrival of the winter blackbird flocks. Depletion was due more to standard agricultural practices such as "plowing under," than by bird usage (Table 2).

The abundance of available seeds decreased steadily at first in the presence of resident doves and blackbirds. Upon arrival of the majority of migratory blackbird flocks, this abundance decreased very sharply. Large flocks of blackbirds were noted actively feeding on a regular basis in the above fields with almost no doves being recorded during the same period.

TABLE 2. Average weekly decrease of browntop millet, sorghum, and corn in 26 study fields across east-central Alabama.

Field number	Decrease, lb/A	
	Before Nov. 23	After Nov. 23
SORGHUM		
1	1.3	---
2	0.3	---
3	0.3	---
4	1.1	---
BROWNTOP-MILLET		
1	187.0	---
2	147.0	---
3	470.0	---
4	361.0	---
5	215.0	---
6	109.0	145.0
7	244.0	452.0
CORN		
1	16.0	40.1
2	21.7	30.0
3	18.3	68.6
4	15.3	---
5	12.4	---
6	9.9	21.7
7	16.6	10.4
8	16.4	---
9	14.0	---
10	20.5	---
11	16.7	---
12	15.0	34.3
13	16.0	---
14	---	180.7
15	14.4	16.1

Competition Between Doves and Blackbirds for Grain

Stickney (6) rated browntop millet very low on the preference list of dove foods, yet doves flock to a field of millet during late summer and early fall because the grain ripens early and is harvested while little else is available in quantity. Blackbirds prefer browntop over most other grains (6). Blackbirds were not present in sufficient numbers nor was their flocking behavior strong enough to cause significant competition with doves when most millet fields were harvested in the study area.

Millet fields designed for early fall dove hunts were not bothered by large numbers of blackbirds, but millet fields maturing in early winter were consumed by blackbirds before the doves were able to completely utilize the grain. However, by this time doves had begun to feed almost exclusively on corn and sorghum and could not be attracted to millet fields with any degree of success.

Stickney (6) stated that whole kernel corn ranked as the number one dove food, while it was rarely taken by blackbirds. Crop analyses of doves and blackbirds in this study supported this statement. Only one whole kernel of corn (0.78%) was found in 131 blackbird crops, although 88.5% contained cracked corn. Of dove crops analyzed, 82.6% contained almost exclusively whole corn. Common grackles are able to eat whole kernels that have been soaked in water, but normally they cannot crack dry kernels.

In summary, there appeared to be little competition between wintering flocks of blackbirds and doves in east-central Alabama. Their feeding habits differed; blackbirds were not observed forcing doves from feeding areas, except under previously mentioned conditions; food preferences differed to a large degree and those foods that appeared preferred by both birds were available to each at a different time of the year.

LITERATURE CITED

1. Keeler, J. E. 1964. Blackbird depredations. Annu. Prog. Report. Ala. Dept. Conser., Div. Game and Fish. Mimeo pp. 175-190B.
2. Meanley, B. and J. S. Webb. 1966. Distribution and ecology of blackbirds and starling roosts in the eastern United States. Prog. Report. Work Units: F-25 and F-25.2 Patuxent Wildlife Research Center. 10 pp.
3. Pearson, A. M. and L. G. Webb. 1942. Mourning dove a strict vegetarian. Ala. Cons. 14:3,12.
4. Peters, H. S. 1961. Past status and management of the mourning dove. Trans. N. Amer. Wildl. Conf. 26:371-374.
5. Ripley, T. H. and C. J. Perkins. 1965. Estimating ground supplies of seed available to Bobwhites. J. Wildl. Mgmt. 29:117-121.
6. Stickney, H. W. 1967. Preferences exhibited by the mourning dove and blackbirds for nineteen kinds of seeds. M.S. thesis. Auburn University. Auburn, Alabama.

INSECTICIDE RESIDUES IN BOBWHITE QUAIL
ASSOCIATED WITH ALABAMA SOYBEAN PRODUCTION¹

Sherwood C. McIntyre, Jr.² and M. Keith Causey
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

INTRODUCTION

Concern about insecticide residues accumulating in the environment is nothing new. It has been fairly well established that almost every component of the biosphere contains detectable amounts of one or more of the chlorinated hydrocarbon insecticides. Contamination of soil, water, fauna and flora is almost universal (8).

Residues of chlorinated hydrocarbon insecticides occur in many wildlife species analyzed in various countries, and the addition of these persistent chemicals to the environment continues (5). Biologists are constantly on the alert for the development of new situations concerning insecticide-wildlife relationships.

The expansion of the soybean market during the past few years has led to large increases in acreages devoted to this crop in Alabama and several other southeastern states. Over 600,000 acres of soybeans were harvested in Alabama in 1970 (11); many fields occurred in areas supporting high populations of bobwhite quail (*Colinus virginianus*). During the 1968 and 1969 growing seasons, such agricultural chemicals as DDT, toxaphene, carbaryl, methyl parathion, and parathion were applied to soybeans to control insects (2).

It was assumed that bobwhite quail ranging in or near these fields would come in contact with some of these chemicals in their normal behavioral activities. This study was conducted to determine the occurrence and magnitude of insecticide contamination in bobwhites found in or adjacent to insecticide-treated soybean fields in Alabama.

MATERIALS AND METHODS

During the summers of 1968 and 1969, landowners in various Alabama counties were contacted to determine if insect control measures had been used in their soybean fields. Kinds and amounts of insecticides used were determined as accurately as possible. Those fields treated with one or more of the chlorinated hydrocarbon insecticides (usually a mixture of DDT, toxaphene, and methyl parathion³) and located in good

¹Contribution of the Alabama Cooperative Wildlife Research Unit, Auburn University Agricultural Experiment Station, Game and Fish Division of the Alabama Department of Conservation, the U. S. Fish and Wildlife Service, and the Wildlife Management Institute cooperating.

²Present address: Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, Alabama.

³An organophosphate

Insecticide Residues in Bobwhite Quail

bobwhite habitat were selected as study areas. Areas located where the habitat had little or no history of chlorinated hydrocarbon insecticide treatment were designated as control areas.

Bobwhites from treated and control areas were hunted with dogs and collected by shooting with shotguns. Twenty birds were collected in or very near insecticide-treated soybean fields in Sumter and Bullock counties. Seventeen bobwhites were collected at Bermingham Plantation in Barbour County; this area has had little or no chlorinated hydrocarbon insecticide applications during the past 12 years. Collected specimens were returned to Auburn for laboratory analyses.

Laboratory preparation consisted of skinning, eviscerating, and removing wings, head, and feet. The dressed quail were chopped into fine particles, placed in $\frac{1}{2}$ -pint cardboard cartons, frozen, and held until analyzed. Pesticide residue analyses were performed at the Alabama State Department of Agriculture and Industry Pesticide Residue Laboratory at Auburn. Clean-up and extraction procedures used are described in the Pesticide Analytical Manual (9).

A No. 701 Hamilton 10 μ l syringe was used to inject 4 μ l portions of tissue extracts into a Varian Aerograph Model 204 Gas Chromatograph to determine the amount of insecticide residues present. Samples were analyzed for chlorinated hydrocarbon and organophosphate insecticide residues. Residue levels less than 0.01 ppm were recorded as trace amounts and amounts were recorded to the nearest 0.01 ppm. Paper chromatography was used to confirm the identification of compounds detected.

RESULTS AND DISCUSSION

Results of the analyses are presented in Tables 1 and 2. All of the specimens analyzed contained DDT or its metabolites. Total DDT residues (technical DDT plus metabolites) in the fat of bobwhites from treated fields averaged 17.08 ppm with a range of 2.07-46.40 ppm (Table 1). An average of 32.24 ppm toxaphene was detected in 5 of the 20 bobwhites from treated areas. The remaining 15 birds from treated areas did not contain reportable quantities of toxaphene. Heptachlor epoxide was found in only 3 birds tested and DDD was detected in 1 bird. Residues of methyl parathion were not detected in any of the birds tested although it had been applied to most of the fields.

All bobwhite quail collected from an area not recently in cultivation contained DDE residues; the average amount detected was 1.68 ppm with a range of 0.55-3.10 ppm (Table 2). Conversion of the residue levels to whole wet-weight basis showed that quail from treated soybean fields contained an average amount of DDT and its metabolites of 0.240 ppm, and birds from the control area contained an average of 0.030 ppm DDE (whole wet-weight basis).

Average DDT residue levels (fat basis) in bobwhite quail from treated and control areas exceeded that tolerated by the Food and Drug Administration (FDA) in commercial poultry. The tolerance level for DDT in the fat of domestic meats is 7 ppm; average amount of DDT in the

TABLE 1. Chlorinated hydrocarbon insecticide residues in bobwhite quail collected from treated soybean fields in Sumter and Bullock counties, Alabama, during 1969.

Quail number	Residue (ppm fat basis)				
	DDT	DDE	Total DDT	Toxaphene	Heptachlor epoxide
1	1.80	5.40	7.20	T	*
2	2.10	20.00	22.10	10.30	*
3	15.40	20.70	36.10	88.90	*
4	T	4.40	4.40	*	1.30
5	5.80	12.80	18.60	26.50	*
6	*	5.80	5.80	*	2.40
7	2.10	12.10	14.20	17.40	*
8	9.65	13.10	22.75	18.75	*
9	*	4.70	4.70	*	*
10	0.36	2.24	2.60	*	*
11	T	9.20	9.20	*	*
12	T	5.65	5.65	*	1.17
13	*	2.16	2.16	*	*
14	*	27.90	27.90	*	*
15	*	18.50	18.50	*	*
16	15.50	30.90	46.40	*	*
17	16.00	23.90	45.60	*	*
18	9.60	17.60	27.20	T	*
19	0.76	1.31	2.07	T	*
20	*	18.50	18.50	*	*
Average	--	--	17.08	--	--
Range	0.76-16.00	1.31-30.90	2.07-46.40	10.30-88.90	1.17-2.40

T = < .01 ppm

* = Undetected

fat of bobwhites associated with DDT-treated soybean fields was 17.08 ppm. There are no federal tolerance levels established for wildlife species used as food.

When reporting results from a study of this nature one is challenged to explain the implications of insecticide residues in a species such as the bobwhite quail. It has been fairly well documented that DDT and metabolites of this compound have had marked effects on the reproductive capacity of several species of birds (1,3,4,6,10). However, residues detected in the bobwhites associated with treated soybean fields were not as high, on the average, as DDT levels in the tissues and eggs of the bird populations suffering from reproductive problems. Hunt and Keith (7) reported DDT residues as high as 3,647 ppm in the fat of ring-neck pheasants (*Phasianus colchicus*) from an area where reduced reproduction was suspected.

The agricultural areas in Alabama from which bobwhites for this study were collected support high populations of the bird. Presently,

Insecticide Residues in Bobwhite Quail

TABLE 2. Chlorinated hydrocarbon insecticide residues in bobwhite quail collected from an area in Barbour County, Alabama, with no recent history of insecticide application.

Quail number	Residue (ppm fat basis)
	DDE (total DDT)
1	3.10
2	1.90
3	2.80
4	0.71
5	1.09
6	2.40
7	0.75
8	0.60
9	1.80
10	1.20
11	1.50
12	0.55
13	2.06
14	1.60
15	2.40
16	1.30
17	2.80
Average	1.68
Range	0.55-3.10

there seems to be no indication of reduced populations in these areas. Further studies along these lines will be conducted.

Because the bobwhite is a very popular game bird, detection of insecticide residues in the test specimens has management implications. The FDA has not established tolerance levels for insecticide residues in game species used as food. FDA officials have suggested season closure in areas where residues in game species were higher than those tolerated in commercial products. Season closures based on residue comparisons, such as recommended by the FDA, could affect large areas in Alabama and cause a serious loss of revenue within the Fish and Game Division of the Alabama Department of Conservation.

It seems desirable for the FDA to establish residue tolerance levels and safety levels for insecticide residues detected in various game species in order to minimize the controversy concerning the significance of residues reported in this and other investigations.

SUMMARY

During the soybean growing seasons of 1968 and 1969, bobwhite quail in or very near insecticide-treated soybean fields in Alabama were

collected and analyzed for chlorinated hydrocarbon and organophosphate insecticide residues. DDT or one of its metabolites was the only insecticide regularly detected in the samples. Bobwhites from treated soybean fields contained an average of 17.08 ppm DDT (fat basis). Toxaphene residues ranging from trace amounts to 88.90 ppm (fat basis) were detected in 5 of 20 bobwhites tested. Heptachlor epoxide residues were detected in 3 test birds. No organophosphate residues were detected. DDE residues averaging 1.68 ppm (fat basis) were detected in bobwhite quail analyzed as controls.

ACKNOWLEDGMENTS

This research was supported by funds granted by the Bureau of Sport Fisheries and Wildlife, Division of Research.

We are grateful for the help of the staff and graduate students of the Alabama Cooperative Wildlife Research Unit for assistance in securing test specimens.

LITERATURE CITED

1. Anderson, D. W. and J. J. Hickey. 1969. Significance of chlorinated hydrocarbon residues to breeding pelicans and cormorants. *The Canadian Field-Naturalist*. 83:91-112.
2. Bass, M. H. 1971. Insects. *In: Soybean production - recent research findings*. Auburn University Agr. Exp. Sta. Bull. 412:70-72.
3. Bitman, Joel. 1969. Hormonal and enzymatic activity of DDT. *Agr. Sci. Rev.* 7:6-12.
4. Cade, T. J., J. L. Lincer, C. M. White, D. G. Roseneau, and L. G. Swartz. 1971. DDE residues and eggshell changes in Alaskan falcons and hawks. *Sci.* 172:955-957.
5. Dustman, E. H. and Lucille Steckel. 1969. The occurrence and significance of pesticide residues in wild animals. *Ann. New York Acad. Sci.* 160:162-172.
6. Heath, R. G., J. W. Spann, and J. F. Kreitzer. 1969. Marked DDE impairment of mallard reproduction in controlled studies. *Nature* 224(5214):47-48.
7. Hunt, E. G. and J. O. Keith. 1962. Pesticide wildlife investigations in California - 1962. The use of agricultural chemicals in California--a summary of the problems and progress in solving them. 27 pp.
8. Newsom, L. D. 1967. Consequences of insecticide use on nontarget organisms. *Annu. Rev. Entomol.* 12:257-286.
9. Pesticide Analytical Manual, Vol. I. U.S. Dept. Health, Ed. and Welfare, Food and Drug Admn. Looseleaf Revised 1968.

Insecticide Residues in Bobwhite Quail

10. Porter, R. D. and S. N. Wiemeyer. 1969. Dieldrin and DDT: Effects on sparrow hawk eggshells and reproduction. *Sci.* 165:199-200.
11. Rogers, H. T. 1971. Introduction. *In*: Soybean production - recent research findings. Auburn University Agr. Exp. Sta. Bull. 413:7.

DESCRIPTIVE SURVEY OF IDENTIFIED X-RAY SOURCES

Robert M. Wilson
Marshall Space Flight Center
Huntsville, Alabama

INTRODUCTION

X-rays, comprising the short wavelength region (0.1 to 100 Å) of the electromagnetic spectrum, are highly attenuated and absorbed by the earth's atmosphere. Therefore, to make direct observations of X-rays, it is mandatory to carry detectors above this absorbing level of the atmosphere. This is accomplished by using rockets, satellites, and balloons. The study of this short wavelength radiation in solar and celestial sources forms the new discipline of X-ray astronomy.

The astronomical (10) study of X-rays had its earliest beginnings in 1948 with Burnight (2) and Purcell, Tousey, and Watanabe (20) in the detection of 1- to 20-Å X-rays from the sun. This was accomplished by using photographic film and filters carried aloft on an Aerobee rocket and allowing exposure of the film to the radiations of the sun. Subsequent observations have shown that the majority of the X-rays emitted by the sun are in the form of spectral lines. More recent observations have revealed the intercorrelations of radio and X-ray data, as well as correlation of X-rays with the flare phenomena.

It was not until June 1962 that cosmic X-ray astronomy had its beginning. During an attempt to detect fluorescence X-rays from the moon, Giacconi *et al.* (10,11) discovered a source of X-ray emission (2 to 8 Å) originating from outside the solar system near the galactic center, more specifically in the direction of the constellation Scorpius. A general isotropic background of X-rays was also revealed. Further observations by others confirmed the initial discovery of cosmic X-rays and also revealed more X-ray sources.

Theoretically, the answers to many of the most fundamental astrophysical problems of stellar evolution, the origin of cosmic rays, and the large-scale structure of the universe are linked with the emission of X-rays and gamma rays (7). Observation of these high-energy rays would therefore be very beneficial toward the understanding of these problems.

Earlier, astrophysicists had calculated the amount of X-radiation to be expected from various potential sources other than the sun and had concluded that X-rays from outside the solar system would probably be too faint to be detected by conventional rocket instruments. Subsequent exploratory scans of the night sky seemed to confirm this prediction. However, since more sensitive instrumentation with higher resolutions came into being, cosmic X-ray astronomy has become one of the "new astronomies" (12).

IDENTIFIED X-RAY SOURCES

Cosmic X-ray astronomy has progressed fairly rapidly since its inception. From the initial discovery of a few X-ray emitters, the list

Descriptive Survey of Identified X-ray Sources

of identified X-ray sources has expanded to 57. Table 1 is a list of identified X-ray sources (21) listed alphabetically by constellation and source giving right ascension [α (1950)] and declination [δ (1950)] locations of the sources, as well as their galactic latitude (b_{II}) and galactic longitude (l_{II}).

Figure 1 is a map (21) of identified X-ray sources. It is a plot of the right ascensions and declinations of the identified X-ray sources in Table 1. The solid line running through the image points represents the galactic equator (galactic plane). Notice the affinity of the image points to the line. This feature is best demonstrated by Figure 2 (21), where the galactic distribution of identified X-ray sources is clearly seen. Once again, the accumulation of X-ray sources near the plane of the galaxy is distinguished as the main feature. The majority of the X-ray sources appear in the galactic latitude band ± 10 degrees. This feature would seem to indicate a galactic origin within our own Milky Way galaxy for these X-ray emitters. Indeed, this is the case.

Although searches (8,9,21) have been restricted mostly to rockets and balloons, some 57 X-ray sources have been resolved against a diffuse, nearly isotropic background radiation. The strongest source is about 2000 times as bright as the weakest detectable with present instruments. Nearly all of the sources lie close to the galactic plane and most likely are members of the spiral arms of the Milky Way. Variability is a common feature.

Flare-like outbursts (8,9) up to 4 times the normal brightness and lasting some 10's of minutes have been observed. Two sources have appeared suddenly, risen to maximum brightness, and decayed with time in a manner similar to the behavior of novae. The X-ray powers (1 to 10 keV) are typically about 10^{36} ergs $^{-1}$, 1000 times the total luminosity of the sun, and Sco X-1, one of the optically identified sources, is 1000 times as bright in X-rays as in visible light. One X-ray source (Virgo X-1) at high galactic latitude is identifiable with a distant radio galaxy, Virgo A (M87), and its X-ray luminosity is 70 times its radio power. A few of the sources have been identified with optical objects; still others have possible optical identifications. Attempts to establish broader correlations with Wolf-Rayet stars, old novae, planetary nebulae, and OB star associations amount to little more than speculation.

Figure 3 (21) represents in graphical form the five most studied X-ray sources and their investigated energy range. Two sources, Tau X-1 and Sco X-1, have been studied most intensively. Tau X-1 (8,9) has been identified with an extended region in the Crab Nebula, about 2 light years in diameter, that contains a pulsar at its center. The pulsar has been observed in the radio, visible, and X-ray spectrum at a frequency of 30 pulses per second. Its X-ray power exceeds its optical power by a factor of 200 and radio power by a factor of 10^4 . Tau X-1 has an extended spectrum which matches a power law to 500 keV and is perhaps the most luminous galactic X-ray source ($L_{1-500 \text{ keV}} \sim 10^{37}$ ergs $^{-1}$). Sco X-1 (8,9) has been identified with a 12th to 13th magnitude blue starlike object (< 0.5 arc s) and its X-ray spectrum fits a thermal bremsstrahlung model at $T \sim 5 \times 10^7$ °K in the range 1 to 10 Å. It may be an order of

TABLE 1. Identified X-ray source locations.

Constellation	Source	$\alpha(1950)$	$\delta(1950)$	l^{II}	b^{II}	Notes
Aquila	Aql X-1	19 ^h 12 ^m	0°			
Ara	Ara X-1	17 ^h 5 ^m	-45.9°			
Cassiopeia	Cas X-1	23 ^h 21 ^m	58.5°	112°	-2°	Cas A
	Cas B	0 ^h 23 ^m	63.9°			
Centaurus	Cen X-1	14 ^h 28 ^m	-63°			Variable
	Cen X-2	13 ^h 24 ^m	-62°			
	Cen X-3	11 ^h 23 ^m	-59°			
Crux	Crux	13.6 ^h	-64°			
		13.7 ^h	-62°			
		13.5 ^h	-66°			
Cepheus	Cep X-1	0 ^h 15 ^m	66°			SN 1572
	Cep X-2	22 ^h 42 ^m	62°			
	Cep X-3	23 ^h 54 ^m	72.9°			
Cygnus	Cyg X-1	19 ^h 53 ^m	34.5°			Variable
		19 ^h 57 ^m	34.5°			
		19 ^h 53 ^m	34.6°	71°	3°	
		19 ^h 58 ^m	35.1°			
	Cyg X-2	19 ^h 56 ^m 34 ^s	35°6'			Optic.ident.
		21 ^h 43 ^m	38.8°	88°	-10°(-11°)	
		21 ^h 42 ^m	38.8°			
		21 ^h 42 ^m	37.2°			
	Cyg X-3	21 ^h 42 ^m 48 ^s	38°11'	87.4°	-11.3°	Cyg A Cyg A
		19 ^h 58 ^m	40.4°			
		19 ^h 58 ^m	40.6°	76°	6°	
		20 ^h 30 ^m	40.9°			
	Cyg X-4	20 ^h 30 ^m 52 ^s	40°56'	80°	0.7°	
		21 ^h 2 ^m	42°			
		21 ^h 9 ^m 11 ^s	38°33'	82.9°	-6.4°	
Lacerta	Lac X-1	22 ^h 34 ^m	53.8°	92 -107°	-7 to -20°	
Leo	Leo X-1	9 ^h 35 ^m	8.6°	226°	41°	
Lupus	Lup X-1	15 ^h 2 ^m	-52°			
		14 ^h 59 ^m	-52°			
Lyra	Lyr X-1	18 ^h 18 ^m	36°			
Norma	Nor X-1	16 ^h 24 ^m	-51°			
	Nor X-2	15 ^h 38 ^m	-57°			
Ophiuchus	Oph X-1	17 ^h 32 ^m	-20.7°	5°	5°	SN 1604
	Oph X-2	17 ^h 14 ^m	-23.5°			
Sagittarius	Sgr X-1	17 ^h 55 ^m	-29.2°	357°	4°	
		17 ^h 48 ^m	-30°			
		17 ^h 44 ^m	-23.2°			
	Sgr X-2	18 ^h 10 ^m	-17.1°	13°	-1°	
		18 ^h 11 ^m	-17.2°			
	Sgr X-3	17 ^h 56 ^m	-21.6°			
		18 ^h 03 ^m	-20.7°			
	Sgr X-4	18 ^h 26 ^m	-31°			
	Sgr X-5	18 ^h 02 ^m	-24.9°			

Descriptive Survey of Identified X-ray Sources

TABLE 1 (Continued)

Constellation	Source	$\alpha(1950)$	$\delta(1950)$	l^{II}	b^{II}	Notes
Sagittarius	GX3+1	17 ^h 43.4 ^m	-26°8'	2.5°	1.3°	Sgr X-1, GX+2.6
Scorpio	GX5-1	17 ^h 58.6 ^m	-25°	5.2°	-1.1°	GX+5.2
	GX9+1	17 ^h 59.7 ^m	-20°32'	9.2°	1°	Sgr X-3, GX+9.1
	GX13+1	18 ^h 10 ^m	-17°8'	13.3°	0.7°	Sgr X-2, GX+13.5
	GX17+2	18 ^h 12.7 ^m	-13°48'	16.6°	1.5°	GX+16.7
	GX9+9	17 ^h 30.2 ^m	-16°36'	8.9°	8.8°	
	GX354-5	17 ^h 47 ^m	-36°	354°	-5°	
	GX(+16.7)	18 ^h 20 ^m	-15°			
	GX(+13.5)	18 ^h 15 ^m	-17.5°			
	GX(+9.1)	18 ^h 05 ^m	-21°			
	GX(+5.2)	17 ^h 55 ^m	-24.5°			
	GX(+2.6)	17 ^h 50 ^m	-27°			
	GX(-2.5)	17 ^h 40 ^m	-31.5°			
	GX(-5.6)	17 ^h 30 ^m	-34°			
	GX(-10.7)	17 ^h 10 ^m	-37.5°			
	GX(-12.9)	16 ^h 50 ^m	-34.5°			
	GX(-14.1)	17 ^h 0 ^m	-40.5°			
Scorpio	Sco X-1	16 ^h 17.07 ^m	-15.53°			Optically ident.
		16.2 ^h	-15°			
		16 ^h 15 ^m	-15°			
		16.3 ^h	-16°			
		16 ^h 15 ^m	-15.2°	359°	23°(24°)	
		16 ^h 17 ^m	-15.5°	359°	23°	
		16 ^h 18 ^m	-15.5°			
		16 ^h 17.01 ^m	-15.33°			
	Sco X-2	17 ^h 15 ^m	-38.4°			
		17 ^h 8 ^m	-36.4°	350°	1°	
		16 ^h 50 ^m	-39.6°	345°	3°	
	Sco X-3	17 ^h 23 ^m	-44.3°	345°	-6°	
	Sco X-4	16 ^h 25 ^m	-40°			
	Sco X-5	17 ^h 37 ^m	-40.4°			
	Sco X-6	18 ^h 7 ^m	-35.6°			
Serpens	Ser X-1	18 ^h 45 ^m	5.3°	37°	2°	
	Ser X-2	18 ^h 10 ^m	-12.9°			
		18 ^h 14 ^m	-14.3°			
Taurus	Tau X-1	5 ^h 31 ^m	22.1°			Optic. ident.
		5 ^h 31.5 ^m	22°	185°	-6°	Crab nebula
		5 ^h 32 ^m	22°	185°	-6°	Crab nebula
		5 ^h 31 ^m 30 ^s	21°59.1'			Crab nebula
Vela	Vel X-1	8 ^h 52 ^m	-44°			
Virgo	Vir X-1	12 ^h 28 ^m	12.7°			Vir A, M87
		12 ^h 28 ^m	12.6°	284°	74°	Vir A, M87
Vulpecula	Vul X-1	20 ^h 38 ^m	29°			

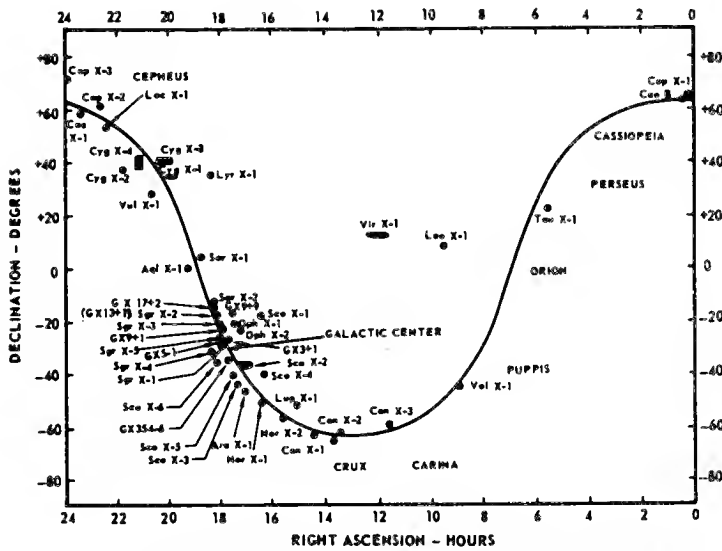


FIGURE 1. Map of identified X-ray sources.

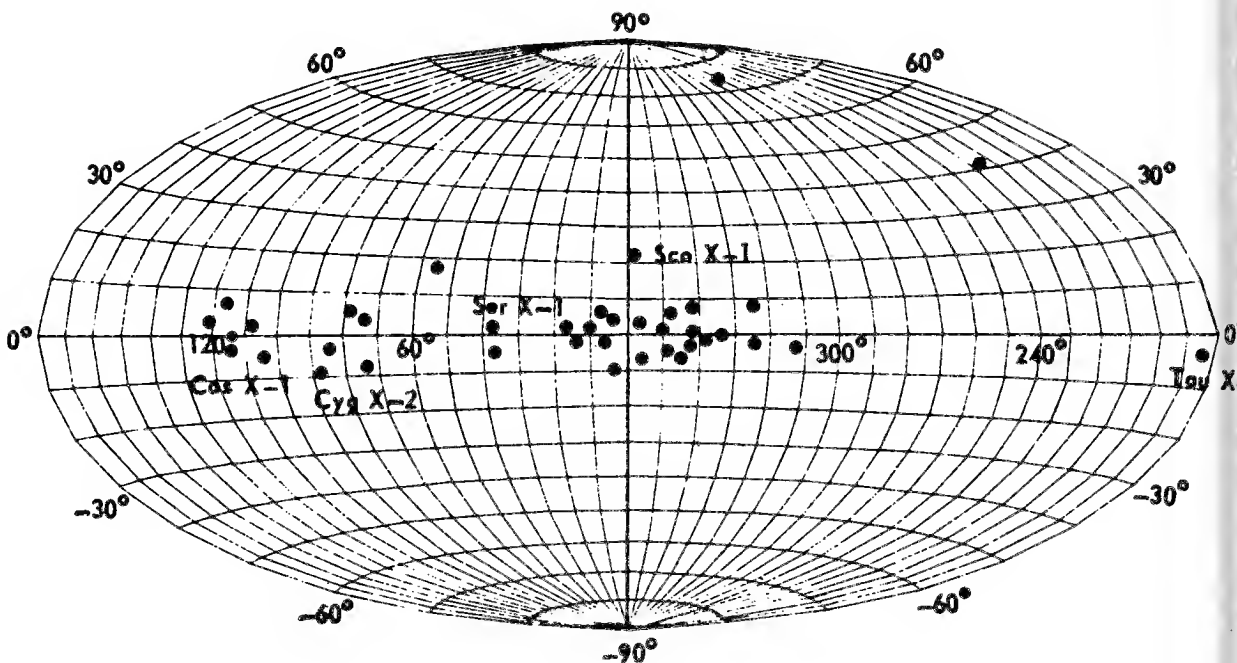


FIGURE 2. Distribution of X-ray sources.

Descriptive Survey of Identified X-ray Sources

magnitude less luminous than Tau X-1 ($L_{1-100 \text{ keV}} \sim 5 \times 10^{36} \text{ erg s}^{-1}$, distance ~ 270 parsec) and is just barely detectable at radio wavelengths. The body of observational evidence is still incomplete and often marginal, even for the most studied sources. Arguments can be constructed for thermal X-ray processes in the Crab and synchrotron emission in Sco X-1. In fact, in the case of Sco X-1, the full spectrum from 0.05 \AA to radio wavelengths is more closely approximated by synchrotron radiation.

Various models have been proposed to explain the existence of cosmic X-ray sources. Among the most popular ones are the supernova remnant in which the formation of a neutron star results, and the close binary model in which a white dwarf or neutron star accretes mass from its companion star (the formation of such a system would result from some supernova-type outburst). Tau X-1 seems to fit the first type while Sco X-1 seems to be a member of the second type. Therefore, these two sources -- Sco X-1 and Tau X-1 -- are looked upon as prototype X-ray sources of two distinct classes of X-ray objects. A generalized model (8,17) applicable to all X-ray sources has been proposed by Morrison and Sartori. In the aftermath of a supernova explosion, they postulate that the energy is largely stored in mass gas motions, magnetic fields and shock waves. As a by-product of energy exchange processes, electrons are accelerated to relativistic energies; eventually, all the energy is transformed to kinetic energy of hot plasma, thereby creating the thermal mechanism which is the active producer of the X-rays.

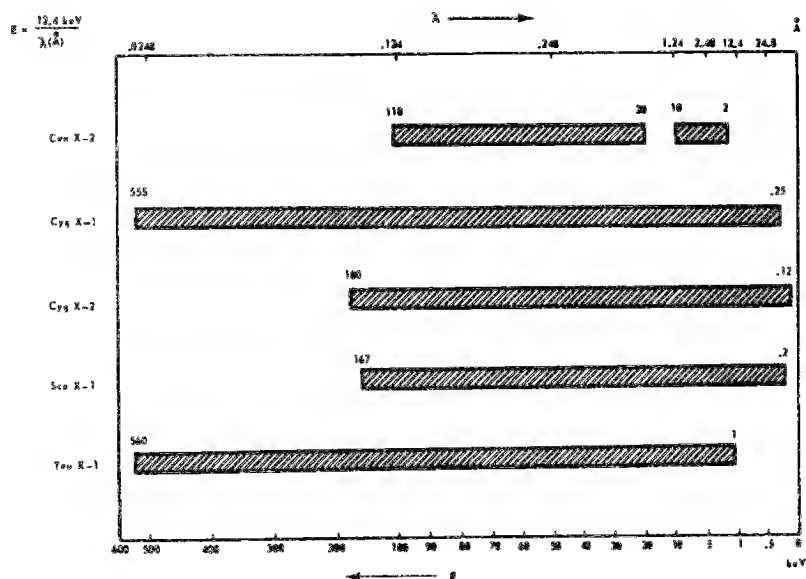


FIGURE 3. The five most studied X-ray sources and their investigated energy range.

X-ray spectral lines (22) have not been observed in the emission from a cosmic source. However, with the introduction of new sensitive instrumentation like Bragg crystal spectrometers, the presence of any spectral lines should be determined. A definite line spectrum will do much for theories of the X-ray sources. For example, in its brief history, Sco X-1 has been considered to be a binary system, a neutron star, a white dwarf, or some other kind of supernova remnant. Looking at it simply there are two possibilities: (1) either the prodigious X-ray output is the thermal emission of a gas (optically thin hot plasma) at something like 50 million degrees which would peak in the X-ray part of the spectrum, or (2) it is due to the synchrotron radiation (possibly an optically thin hot plasma with large temperature gradient) which is the characteristic emission of high-energy electrons controlled by a magnetic field. In fact, the observations favor emission by electrons with a thermal velocity distribution, but with the process of emission being the bremsstrahlung process by which electrons retarded by the powerful magnetic field of another particle emit radiation. Determining a line spectrum in Sco X-1 would allow possible abundance determination of the elements and the conditions in which they exist.

Sco X-1 (8) exhibits many more interesting features. Its light curve suggests an eclipse, although no radial velocity has as yet been established (19). It has been observed to vary (amplitude about 1 magnitude) on the average of 0.3 magnitude per hour (8). Variability is indicated in both temperature and X-ray flux and one balloon observation (16) detected what may be described as a flare -- a fourfold increase in flux within a matter of minutes. Perhaps the most remarkable feature of the X-ray star is that more than 99% of its total luminosity is concentrated in the X-ray range (8). The optical object identified with Sco X-1 has some of the variability characteristics of an old nova, but its spectrum shows significant differences. A flickering (17) has been noted during the bright phase and seems to be strongly correlated to the bright phase emission, a fact which disagrees with old nova or nova-like variable data. Because of the nova-like optical variations and because ex-novae are generally close binary systems, there has been much discussion concerning binary models that could account for the observed X-ray emission. The optical features suggest that it may be possible to trace the origin of the time variations to orbital motions of a bright source and a flickering source with various possible eclipsing configurations. There is as yet no clearly demonstrated periodicity in either the light curve or the X-ray emission, but the orbital plane could be perpendicular to the line of sight or the period could be very short (8). One component of a nova-like binary is typically highly evolved, possibly a white dwarf; the other is usually a red giant. In such a system, gas streams to the compact star. Shklovsky has proposed a binary model in which one component is a neutron star (8). He proposed further that where the X-ray flux of about 10^{13} erg cm⁻²s⁻¹ reaches the surface of the red companion star, its temperature could increase to 30,000 °K or more, and its color would change to blue. Fluctuations in X-ray brightness could be accompanied by color changes, which are in fact observed. In this model, the visible object is the companion star, not the X-ray source, and the visible extension of the bremsstrahlung spectrum is presumably strongly reduced by the opacity of cooler gas outside the fireball. The optical emission line spectrum implies that, whatever the nature of the fireball,

Descriptive Survey of Identified X-ray Sources

it must be surrounded by a cooler sheath of gas at about 10^4 to 10^8 °K and a density of 5×10^7 cm $^{-3}$, or greater. Cameron and Mock have given further consideration to mass accretion models and find that accretion onto a white dwarf fits the observed parameters of Sco X-1 better than Shklovsky's neutron star model (8). Other interpretations have also been advanced. Additional optical features include a flat continuum extending into the blue or ultraviolet range, and an exponential spectrum in the X-ray range. It lacks absorption lines except Ca II (K) which may be attributed to interstellar absorption. Emission lines of Balmer and He II (λ 4686) have been observed.

Tau X-1 (8) evidently results from the supernova explosion recorded in 1054 A.D. in the Crab. Occultation experiments to determine a more exact position of Tau X-1 in the Crab have been performed (1,14). It was determined that the X-ray emission did indeed emanate from the Crab from a finite extended region (~ 2 light years in diameter) rather than a point source. Now, the gaseous debris seems to fill an ellipsoidal volume about 6 light years across its major axis and the envelope is still expanding at about 1000 km s $^{-1}$. The nebula consists of an "amorphous core of white light enmeshed in tangled filaments of red glowing hydrogen" (8). Because the white light continuum is strongly polarized, it was recognized that the radiation is synchrotron. Powerful radio emission originates in a volume somewhat larger than the white light nebula and is also strongly polarized, again suggesting synchrotron emission. Theoretical arguments have placed values of the magnetic field between 10^{-3} and 10^{-4} gauss. The electrons responsible for the synchrotron emission must therefore have energies of the order of 10^5 of MeV to produce radio frequencies, 10^4 to 10^6 MeV for optical frequencies, and about 10^8 MeV for X-ray frequencies. Arguments have been offered for the existence of many hot regions within the nebula, with a range of temperatures that produce X-ray bremsstrahlung, although no clear theory has been advanced for the development of such a multiplicity of hot regions.

Cyg X-1 also shows a time variation in brightness (intensity), similar to other X-ray sources (4, 14, 18). There have been two reports of a decrease by a factor of 3 to 6 in the 1- to 10- keV X-ray flux relative to earlier measurements. Also, a twofold increase (18) of the high-energy X-ray flux was reported between September 1966 and May 1967. It is generally believed that Cyg X-1 demonstrates a power law spectrum (15), somewhat similar to Tau X-1 at balloon energies, although an exponential function (bremsstrahlung) could also fit equally well with no low energy attenuation required (13). An optical search was unsuccessful in yielding a candidate object for Cyg X-1 (14). The failure to find an optical object may be due to obscuration, but could also be that Cyg X-1 is an entirely new type of X-ray source. Much work is still needed on this source.

Cyg X-2, on the other hand, has a softer spectrum than Cyg X-1 (13). It seems to exhibit an exponential spectrum with some low-energy attenuation, although evidence of a faint radio source has been observed which indicates a possible nonthermal component with a thermal one as well. It seems to be similar (17) to Sco X-1, although many differences do exist. Cyg X-2 seems to have been identified optically with a blue, starlike object (8). The object exhibits an unusual ultraviolet intensity

and rapid time variation of visual intensity. The identification is less reliable as compared to Sco X-1 because of a great number of stars included within the error box of the location. Several observations of this object have been reported. Lynds found He II (λ 4686) in emission with a radial velocity and hydrogen Balmer lines and Ca II (K) in absorption (17). Burbidge confirmed these general features (17). This led to the idea that Cyg X-2 is a spectroscopic binary of very short period (5 to 7 hr) seen from a direction in or near the orbital plane (8). Kristian, Sandage and Westphal also reported rapid photometric and spectroscopic variations (17). A light curve characterized by the peaked semiperiodical oscillations of an amplitude of 0.04 magnitude superimposed on a 0.1-magnitude fluctuation of 1-hr period gradually declining during this period is considered to be evidence for identification of the candidate star with Cyg X-2. One of the components (8) seems to be a normal G-type star and the distance is about 600 parsec. Unlike Sco X-1, the optical radiation of the sun-like star is much brighter than the extrapolated bremsstrahlung of the 4×10^7 °K X-ray spectrum. Some doubt is therefore still associated with the identification. Peimbert, *et al.* propose that the spectral continuum can be explained by the summation of the expected optical bremsstrahlung from the compact star and the continuum of its G-type companion (8). Assuming the correctness of the identification, Prendergast and Burbidge (8,19) have devised a binary star model to explain it. They suggest that there is nothing in the optical observations of both Sco X-1 and Cyg X-2 that has not been reported in other complicated binary systems. The only differences between normal binary systems and those exhibiting X-ray emission may be the closeness of the components and the size and density of the components.

Cen X-2 has shown a most remarkable variability (3,5,6,8). Some time between October 1965, when it was not detectable, and April 1967, it became the brightest X-ray source so far observed in the 1- to 10-keV range. It then diminished in intensity and disappeared from view in September or October 1967, approximately 6 months after reaching peak brightness. It has been noted that this behavior very much parallels a typical nova outburst in visible light. Extrapolation of a bremsstrahlung spectrum would have made it appear as a +10 to +5 magnitude object at maximum. From such considerations, a distance of from 5 to 14 kpc is inferred together with a maximum X-ray luminosity, possibly as high as 10^{39} erg s⁻¹ or 1000 times the power of Sco X-1. An optical identification with the variable star WX Cen has been suggested. The star has a very blue color similar to Sco X-1, and varies from night to night by $\Delta V \sim 0.4$ magnitude. However, scattered optical observations in May 1967 and March 1968 do not support the idea of a nova eruption in March or April 1967. Optical records of this star go back some 60 years, but no evidence of violent outbursts is seen. In many details the spectrum closely resembles that of Sco X-1 and suggests a comparable distance of the order of 600 parsec and luminosity of about 10^{36} erg s⁻¹.

The variability of Cen X-2 is readily seen in comparison with Sco X-1 in Figure 4 (6). Notice the steady drop of the intensity over the 1- to 10-keV range during the short period April 4, 1967 to May 18, 1967. Sco X-1 remained fairly stable over this same period. The X-ray spectra

Descriptive Survey of Identified X-ray Sources

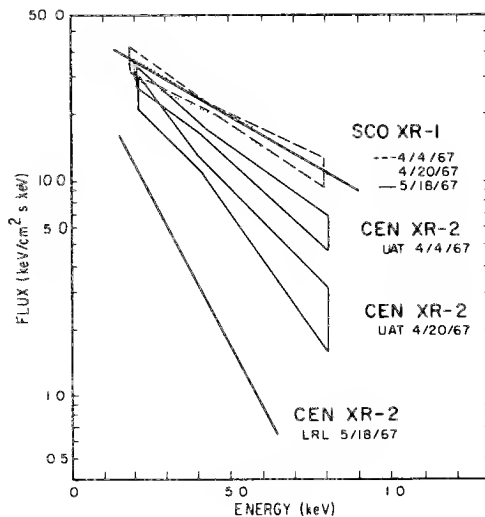


FIGURE 4. The spectra of Sco XR-1 and Cen XR-2.

of Sco X-1, Tau X-1, Cyg X-1, and Cyg X-2 are shown in Figure 5. A comparison of these figures indicates that Sco X-1 is indeed the strongest X-ray emitter in soft X-ray radiation, while Tau X-1 is stronger in the harder X-ray radiation.

FUTURE EXPERIMENTATION

Much more work remains in the field of cosmic X-ray astronomy. More precise X-ray positions are needed, and X-ray periodicities must be searched in the frequency range from a few msec to 1 or 2 sec. More accurate distance determinations should be secured. Continued spectroscopic and photometric observations of possible candidate stars within the error boxes of the X-ray object should be acquired. Congruent radio observations would be helpful. Definitive observations are needed to provide evidence of thermal or nonthermal processes. Detection of X-ray polarization would point strongly to the synchrotron process; detection of X-ray emission lines would reveal a thermal mechanism. Both types of requirements are just marginally possible with Aerobee class rockets; both could be accomplished with an orbiting observatory. These large instrumented satellites carrying much refined instrumentation and advanced detectors would be extremely helpful. A large orbiting X-ray telescope facility would be highly desirable. Such a system is now being readied for flight in solar X-ray astronomy with the Apollo Telescope Mount. A similar program is currently being studied for cosmic X-ray

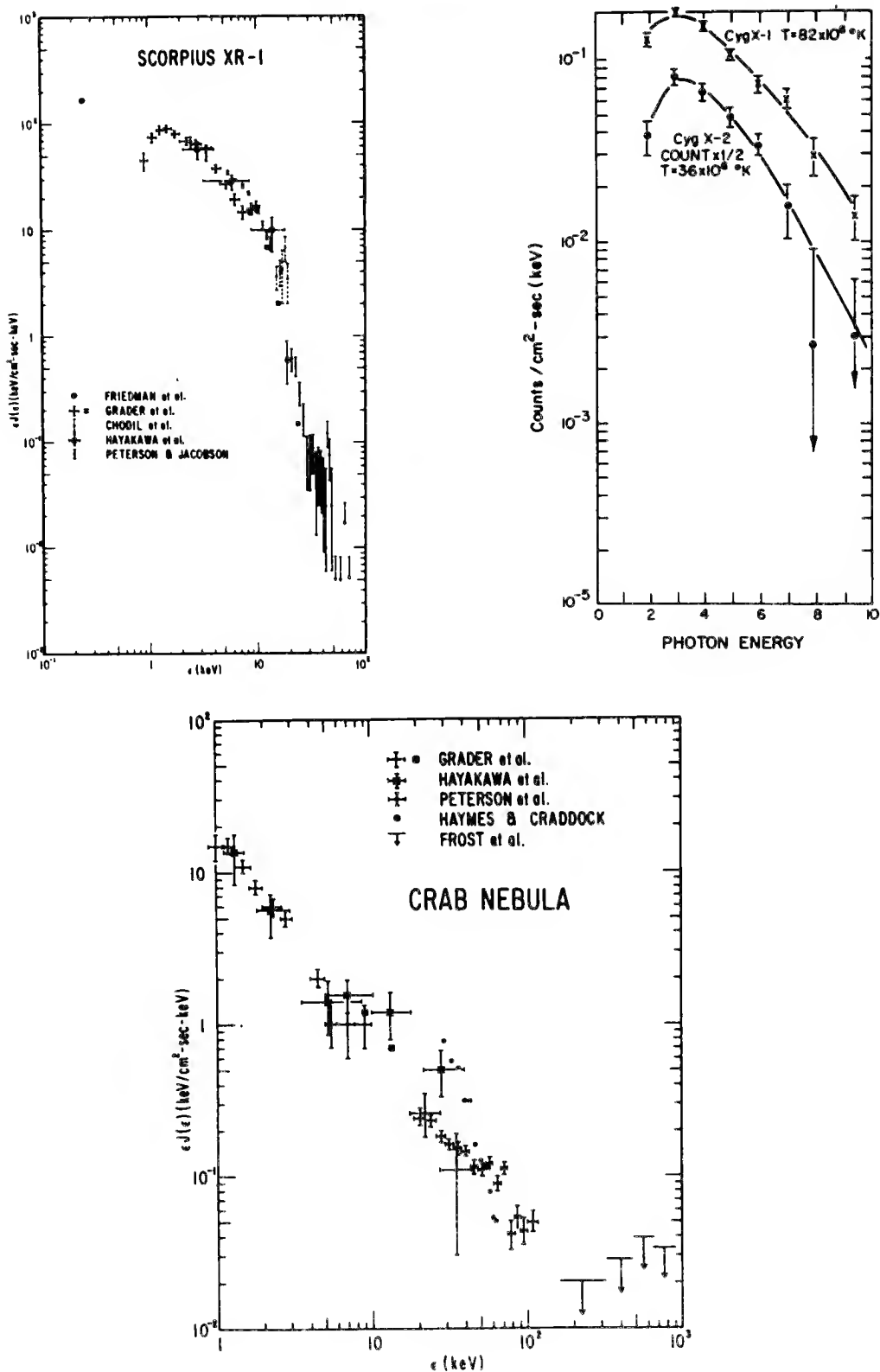


FIGURE 5. Measurements of the spectra of Sco XR-1 (left), Cyg X-2 (right), and Crab Nebula (bottom).

Descriptive Survey of Identified X-ray Sources

astronomy, the High Energy Astronomy Observatory. To aid in the development of this program, supporting research and technology are being conducted to determine reflection efficiencies of various materials that may be used in the construction of a large X-ray telescope facility and to define and develop the instrumentation.

The unequivocal (22) detection of X-ray lines in the emission from a cosmic source may very well be the next big news break in X-ray astronomy. The Leicester and Columbia groups are preparing competitive experiments to determine without a doubt the existence of X-ray spectral lines. The Goddard Space Flight Center group has come closest to the prize so far. In 150 sec of observing time of the X-ray source Sco X-1, they found strong indications for line (iron) emission at energies of a few keV but add that conclusive evidence is still lacking. With the introduction of a new type of instrumentation (Bragg crystal spectrometer) in flights planned for this spring, the gap ought to be filled. The Columbia group is said to be concentrating on a sulphur line while the Leicester group will be looking for the same iron line which was reported by Holt *et al.* At the temperatures expected in Sco X-1 the iron must be in an exotic state; it is expected to be stripped of all but two of its electrons, which means it will have a helium-like spectrum but shifted to shorter wavelengths because of the larger atomic number. Thus, the line discussed by Holt *et al.* and to be searched for by the Leicester group has a wavelength of about 1.9 \AA , corresponding to about 6.7 keV. If all goes well, by this time next year a lot more should be known about the abundance of the elements in Sco X-1 and the conditions in which they exist. Indeed, with continued support, X-ray astronomy should be most prosperous in this new decade.

LITERATURE CITED

1. Bowyer, S., E. T. Byram, T. A. Chubb and H. Friedman. 1964. Lunar occultation of X-ray emission from the Crab Nebula. *Science* 146: 912-916.
2. Burnight, T. R. 1949. Soft X-radiation in the upper atmosphere. *Phys. Rev.* 76:165.
3. Chodil, G., H. Mark, R. Rodrigues, F. Seward, C. D. Swift, W. A. Hiltner, G. Wallerstein, and E. J. Mannery. 1967. Spectral and location measurements of several cosmic X-ray sources including a variable source in Centaurus. *Phys. Rev. Letters* 19:681-683.
4. Chodil, G., H. Mark, R. Rodrigues, and C. D. Swift. 1968. Observation of the Cygnus region with a balloon-borne X-ray detector. *Astrophys. J.* 151:L1-L4.
5. Chubb, T. A. and H. Friedman. 1969. Glimpsing the hidden universe. *Astron. and Aeron.*, March:50-55.
6. Francey, R. J., A. G. Fenton, J. R. Harries, and K. G. McCracken. 1967. Variability of Centaurus XR-2. *Nature* 216:773-774.
7. Friedman, H. 1965. Cosmic X-rays and gamma rays. *Astron. and Aeron.*, October:8-12.

8. Friedman, H. 1968. Cosmic X-rays. *Nature* 220:862-865.
9. Friedman, H. 1969. X-ray and gamma-ray astronomy. *Science* 166: 1045-1046.
10. Garmire, G. 1966. X-ray astronomy. *N. Y. Acad. Sci.* 140:172-174.
11. Giacconi, R., H. Gursky, F. Paolini, and B. Rossi. 1962. Evidence for X-rays from sources outside the solar system. *Phys. Rev.* 9: 439-443.
12. Goldberg, L. 1965. The new astronomies. *Int. Sci. and Tech.*, August:18-27.
13. Gorenstein, P., R. Giacconi, and H. Gursky. 1967. The spectra of several X-ray sources in Cygnus and Scorpio. *Astrophys. J.* 150: L85-L94.
14. Gursky, H. 1967. Recent development in X-ray astronomy. ASE-1673a.
15. Hayakawa, S. 1967. Galactic X-ray sources. *Int. Conf. Cos. Rays*, 10th, Calgary, Canada, Accession No. A69-12930:82-105.
16. Lewin, W. H. G., G. W. Clark, and W. B. Smith. 1968. Observation of an X-ray flare from Sco X-1. *Astrophys. J.* 152:L55-L62.
17. Oda, M. 1968. Optical identification and interpretation of X-ray sources. *Space Sci. Rev.* 8:507-533.
18. Overbeck, J. W. and H. D. Tanabaum. 1968. Twofold increase of the high-energy X-ray flux from Cygnus XR-1. *Phys. Rev. Letters* 20: 24-27.
19. Prendergast, K. H. and G. R. Burbidge. 1968. On the nature of some galactic X-ray sources. *Astrophys. J.* 151:L83-L88.
20. Purcell, T. D., R. Tousey, and K. Watanabe. 1949. Observations at high altitudes of extreme ultraviolet and X-rays from the sun. *Phys. Rev.* 76:165-166.
21. Wilson, R. M., J. M. Reynolds, and S. A. Fields. 1969. A stellar X-ray astronomy summary and bibliography. NASA TM X-53952. September 30.
22. X-ray astronomy: race to verify iron line. 1970. *Nature* 225: 223-224.

The Image of Alabama

THE IMAGE OF ALABAMA: PROBLEMS AND PROSPECTS

Samuel H. Himes, Jr.
Department of Marketing
University of Alabama, University

INTRODUCTION

The task of attracting industry and people to a particular geographic area is one which consumes a considerable amount of time, effort, and money. Ranging from the detailed information made available by state agencies and chambers of commerce to the rhetoric of political leaders, the inducements offered to outsiders to move their businesses and themselves to an area--or to visit that place as a tourist--seem to occupy an ample amount of space in the communications media.

The desire for growth in this country encourages geographic divisions such as states, counties, and cities to aid the process of natural increase (excess of births over deaths) by means of active campaigns aimed both at the encouragement of in-migration of new residents and the halting of an exodus of native sons. In addition, the economic conditions of certain areas point--for example--to needs for broader economic bases, for increased employment levels, or for additional revenue from taxes. Most geographic entities would seem, therefore, to have some basis for an interest in the problem of marketing their "product"--that is, their state, county, or city--in order to accomplish one or more of these objectives. In fact, many states and localities are engaged in this marketing task.

For some political subdivisions, however, such efforts may--at present--be wastes of time, money, and effort. This paper seeks to explore that proposition as it relates to the State of Alabama.

IMAGERY IN MARKETING

In order to market a product, service, or idea, a businessman must first be responsive to some need or desire on the part of a consumer. Marketing deals with the activities in getting a product, service, or idea from its producer to its ultimate consumer. If the consumer does not have a need or desire for a product, efforts aimed at marketing that product likely will not meet with much success. The same might be said for the marketing of a geographic unit such as a state.

THE MARKETING OF A STATE

A state is a product in that it is a physical entity with a set of characteristics which presumably have the ability to satisfy some combination of consumer needs or desires--whether those consumers be residents of the state or non-residents who have a need for services rendered by the state. Particularly in the latter sense, one might think of a state as a "service." A state is also an idea--a mix of impressions, attitudes, predispositions, prejudices, actions, reactions, *ad infinitum*. Marketing guidelines apply to products, to services, and to ideas, and therefore should be relevant to the problems of a geographic division which can be

considered as embodying elements of all three. The focus of this paper, however, is upon Alabama as an "idea".

One method for examining the effectiveness of a state as a product and as a service--but most particularly as an idea--is to analyze the problem in terms of the "image" which the state projects. Research has indicated that the response which individuals make to a particular product, service, or idea is based upon a combination of objective and subjective factors (6). In some cases, a person's reaction is determined primarily by subjective evaluation, since people are not--contrary to their own opinions--exclusively rational beings. In marketing strategy, one must take both objective and subjective factors into account, since both will have an effect upon the ultimate success of a product, service, or idea.

The concept of imagery as applied to products has been variously defined as "the total set of attitudes (about the product)...," (4) "a loose structure of knowledge, belief, and feelings...," (8) and "the personality of a brand (or company), all the things associated with it or perceived about it, the commonly held views about it" (2). These sample definitions convey something of the intangibility of images--the combination of rationality and irrationality and the difficulty in utilizing objective arguments in order to convince. Images can be of vital importance to the marketer, however, since research has determined that the extent to which people react favorably to a marketing strategy varies directly with the degree to which the product, service, or idea possess a favorable image (3). Further, images are often used by individuals as benchmarks by which they compare a product, a service, or an idea to its alternatives or competitors. In sum, imagery performs a vital role in the determination of marketing success.

IMAGERY AND GEOGRAPHY

An intriguing example of the concept of imagery as applied to geographic units is the work which has been done in the area of "mental maps." Such maps are simple relationships which an individual makes between his own geographic area and the remainder of the country. For example, a Texan likely views Texas as occupying a considerable portion of the land mass of the United States. The remainder of the country is of little consequence. A New Yorker perceives the New York/New England area in some detail, while he aggregates most other areas of the country into a relatively small portion of the map (5). Presumably, the research methods which have confirmed these stereotyped images hold for any "mental map"--including that of Alabama.

BASES FOR THIS STUDY

Earlier research efforts aimed at the determination of the effect which mental maps exert upon the area of search which a person might employ in seeking a new industrial location or place of residence. The chances of an individual's including a particular state in his search are limited by two principal factors. As a decision-maker, the businessman cannot know about all of the possible alternatives due to a lack of information about them. In addition he eliminates some geographic areas

The Image of Alabama

from consideration on emotional grounds (the images referred to above) (1). If one could correct the image problems in such a situation, the potential businessman or resident can evaluate the state on the basis of objective information. Research in this area is aimed toward that end.

University students have been used as subjects for this type of research because their mental stereotypes of certain geographic areas might not be so firmly fixed as those of older individuals (1). An additional justification for the use of university students is that such individuals are often rather mobile and constitute the kind of new businessman or resident which states might wish to attract.

Researchers in a previous effort have asked students where they would locate if given free choice, and have requested the students to respond to each state in the Union in terms of their inclination to live and work in that state. The possible responses in the latter instance were "favorable", "unfavorable", or "indifferent".

In reporting the preliminary results of that study, previous researchers noted that Alabama and Mississippi are in a class by themselves--at the unfavorable end of the spectrum. In fact, Alabama and Mississippi were rejected as unfavorable by more than 75% of the respondents. Certain other areas (the remainder of the Deep South, West Virginia, and the Dakotas--for example) received unfavorable ratings, but nowhere is the problem so acute as in the case of the images of Alabama and Mississippi. In a similar study,¹ 84% of respondents (students at universities outside Alabama) rated Alabama as unfavorable; 2% regarded the state favorably, while 14% viewed Alabama with indifference.

The first decision concerning the current study was the elimination of the image of Mississippi as an element for consideration. This simply allows the work to focus upon the one state of greatest interest to most Alabamians, and does not reflect any contention that the image of Mississippi is more or less fruitful as an area for study. With the focus firmly upon Alabama, the next step was to determine the nature and scope of the study of Alabama's image.

STUDY OF ALABAMA'S IMAGE

The respondents for this study consisted of the presidents of each chapter of three national college social fraternities. These individuals lend themselves to study due to their geographic dispersion and leadership positions. Principally these respondents are useful subjects because of their roles as college students, their mobility, and the desirability of such individuals as residents. While this group may seem to be rather narrow for study, the choice is justified for an exploratory study in which the results are to be interpreted as guidelines for future study.

The researcher mailed questionnaires to each of the individuals who satisfied the study criteria, and received 185 usable questionnaires in return. The responses came from 38 states and Canada.

¹Himes, S. H., Jr. Unpublished data.

The study questionnaire inquired about some socio-economic characteristics of the individual and his career aspirations. Also, the respondent was to specify the general area of the United States in which he would prefer to live and work, and to rank the five states which he would most like to live. Seven percent of the respondents ranked Alabama as one of their first five choices. Each of the three individuals who listed Alabama as their first choice was an Alabamian.

The portion of the questionnaire upon which this paper focuses is that which asked the respondents to indicate his image of Alabama in terms of five areas -- 1) the social system, 2) job opportunities, 3) educational facilities, 4) the political system, and 5) climate. He could respond along a seven-point scale ranging from "extremely favorable" to "extremely unfavorable." For purposes of this paper, the responses were aggregated as either "favorable" or "unfavorable." In addition, an open-end question concerning Alabama allowed the respondent to expand upon his remarks if he chose to do so; 57% did so choose.

ELEMENTS OF ALABAMA'S IMAGE

Social System

Results of the study indicated that respondents had a decidedly negative image of social conditions in Alabama. In fact, almost two-thirds of the students characterized their image of Alabama's social system as unfavorable. A majority of negative opinions was expressed by individuals who had never visited Alabama or who had not been in the state for sufficient time to form what they considered to be a first-hand opinion. The opposite was true for the positive reactions.

One may gain additional insight concerning those responses by examining some of the open-end comments of respondents. Many of the respondents cited the mass media and movies as sources of their opinions concerning Alabama. Some felt that the news media had harmed Alabama's national image. A number of students mentioned that their negative opinions concerning Alabama were the result of unpleasant personal experiences. One respondent indicated that he and a friend once hitch-hiked through Alabama en route to Florida. He felt that the people with whom he had contact in Alabama disliked strangers, were basically hostile, and treated him and his friend with suspicion. Regardless of the circumstances of such incidents, the important point - from a marketing standpoint - is that they were significant to the respondent in formulating his image of Alabama.

Many of the respondents mentioned that they believed white Alabamians were ultra-conservative and socially prejudiced toward blacks. They felt that the racial problem and the publicity resulting from it had worked to impede Alabama's social progress. Governor George Wallace seemed to be the principal target of criticism in this regard. A large number of respondents blamed him for their negative opinions of Alabama. While most of those students had not visited in Alabama long enough to form a first-hand opinion, an effective marketing communications strategy on the part of Alabama and Alabamians might help to improve this image.

The Image of Alabama

Job Opportunities

While the variable of job opportunities in Alabama received a somewhat negative rating (42% unfavorable versus 27% favorable), the most striking feature of the responses to this question was that 30% of all respondents did not venture any opinion concerning Alabama job opportunities - presumably due to the lack of information or interest, or both. While 18% of the students who had visited in Alabama expressed no opinion (as opposed to 40% of the non-visitors), those respondents who had visited the state reacted more negatively to the job opportunities than did those who had not been in Alabama (but who registered an opinion). Most of the "no opinion" responses in both instances came from students who lived some distance from Alabama.

Despite all of the industrial growth which Alabama has experienced in recent years, the news evidently has not sufficiently reached beyond the immediate vicinity of the state. The fact that such a large number of respondents did not have an opinion of any kind concerning Alabama job opportunities indicated a significant opportunity for a marketing program which would communicate salient facts concerning Alabama business to prospective employees and employers. The most advantageous position for a marketer in terms of creating an image occurs when the consumer has no opinion concerning a product. In such a situation, the marketer does not face the task of undoing a negative image. The results of this study demonstrated that the marketer of Alabama job opportunities might plan a strategy around this point.

Educational Facilities

The educational facilities of Alabama were negatively rated by 58% of the respondents, while 28% indicated a favorable opinion. This negative reaction was smaller than that concerning the political system of Alabama, and was less strongly unfavorable (judging by the detailed analysis of the scaled responses). Nevertheless, the results were not particularly encouraging for the image of Alabama. Interestingly, the students who had visited in Alabama reacted more negatively to the educational facilities of the state -- as they did to the job opportunities -- than did non-visitors, though the "no opinion" group was considerably larger in the latter category of respondents.

Education is the one area among all of those investigated which is subjected to extensive rating by presumably objective evaluators. The Research Division of the National Education Association publishes an annual volume in which all of the 50 states are ranked in terms of numerous categories of interest to educators. Some of the figures from this publication bear consideration in terms of the image of Alabama. In 1969, Alabama ranked last among the states in terms of per pupil expenditures for public elementary and secondary schools. Alabama also ranked 50th in total public school revenue per pupil (7). Such figures likely would cause concern in an individual who was considering a move to Alabama. For example, schoolteachers would be interested in the fact that Alabama ranked 47th in estimated average salaries of all teachers in public schools.

Political System

The political system of Alabama fared worst among the variables studied. Sixty-seven percent of all respondents reacted unfavorably. In fact, more than one-fourth of the students indicated that their image of the Alabama political system was "extremely unfavorable" (the polar category on the negative end of the scale). While 18% reacted favorably, those responses were skewed toward the neutral center of the scale rather than toward the "extremely favorable" category. In addition, most of the students who were well-disposed toward the Alabama political system resided in states which were geographically proximate to Alabama. As in the case of the social system, the majority of respondents who answered the open-end comment question considered the Alabama political system to be synonymous with George Wallace.

Many of the same elements which would enter into a marketing communications program aimed at improving the image of the social system in Alabama are applicable to a strategy concerning the image of the Alabama political system. In both of those instances, the marketer would seem to be working from an initial disadvantage, since the image of both variables is so unfavorable. Nevertheless, adequate problem definition and effective use of the mass media in order to promote Alabama might serve to ameliorate the situation to some degree.

Climate

Of the five variables investigated in this scaled-response study, only the climate of Alabama received a favorable response from a majority of respondents. Seventy percent of the students felt well-disposed toward Alabama's climate. Most of the 18% who reacted unfavorably attended universities in the northern portion of the country, and preferred colder winter weather than Alabama offered. The "no opinion" category contained only 8% of respondents.

The largely favorable reaction to the climate of Alabama suggests a natural starting point for a marketing communications strategy. While some efforts have been made in this direction, the effect evidently has not been sufficient to attract large numbers of tourists or new residents to the state. A marketer might integrate the climate factor into discussion of the industrial capabilities of Alabama. Some respondents mentioned that they believed Alabama had considerable economic potential -- particularly in the Tennessee Valley area.

A marketer of Alabama might mention climate in connection with another area toward which respondents indicated a favorable reaction -- Alabama sports activities. In addition to maximum utilization of coverage of the regional and national sports events which take place in Alabama or which involve Alabama teams, a marketing communications strategy could emphasize the opportunities which Alabama provides for individual sports and recreation.

CONCLUSION

The image of Alabama is unfavorable in many respects. While the image might not improve quickly through the application of an effective

The Image of Alabama

marketing strategy, such a program would seem to constitute a viable first step. Advancement of Alabama's image to the point of indifference among non-residents would be a sign of progress. If Alabama intends to compete successfully for new businesses, jobs, and residents, effective use of the techniques of marketing communications should provide a meaningful instrument for accomplishment of those objectives.

LITERATURE CITED

1. Aangeenbrug, Robert T. 1968. Regional perception and its effect on industrial location. *Kansas Bus. Rev.* 21:3-4.
2. Frey, A. W. 1961. *Advertising*. 3rd ed. Ronald Press, New York p. 19.
3. Heidingsfield, Myron S. 1968. *Changing patterns in marketing*. Allyn & Bacon, Inc., Boston, p. 94.
4. Martineau, Pierre. 1957. *Motivation in advertising*. McGraw-Hill Book Company, Inc., New York. p. 146.
5. McCarthy, E. Jerome. 1968. *Basic marketing: a managerial approach*. Richard D. Irwin, Inc., Homewood, Ill., pp. 100-101.
6. Nelson, Bardin H. 1962. Seven principles in image formation. *J. Marketing Res.* 26:68.
7. *Rankings of the states*. 1969. Research Report 1969-R1, National Education Association, Washington.
8. Riley, J. W., Jr. 1963. *The corporation and its publics*. John Wiley and Sons, Inc., New York, p. 50.

FEDERAL HIGHWAY SAFETY PROGRAMS--
ORGANIZATIONAL DISUNITY

Grant M. Davis
College of Business Administration
University of Arkansas, Fayetteville

INTRODUCTION

The motor vehicle mode of transportation has unequivocally produced a prodigious socio-economic impact upon western civilization, and America in particular. Indeed, in excess of 100 million busses, trucks, and automobiles were registered in the United States during 1967.¹ More automobiles are operated in this country than the combined number found in the remainder of the world.

Even though motor vehicle transportation is perhaps the single most significant innovation of the 20th century, it is not without detrimental aspects. In this regard, former President Lyndon B. Johnson, observed:

Last year the highway death toll set a new record...the number of Americans killed in this way since the introduction of the automobile is truly unbelievable. It is 1.5 million--more than all of the combat deaths suffered in all our wars. No other necessity of modern life has brought more convenience to the American people--or more tragedy--than the automobile.²

The former chief executive also surmized that the combination of inadequate financing for highway safety and a lack of intermodal safety priorities were fundamentally responsible for the inordinate number of highway fatalities and injuries.³ To correct these two obvious deficiencies, the Department of Transportation was established, and the recommended increased resource allocations to highway safety was made.⁴

In terms of financial and human resource consumption, misallocations, and waste, the automobile is without a contemporary equal. That is to say, fatalities and injuries associated with motor vehicle utilization are enormous. More than 53 thousand Americans were killed and 4.2 million injured in automobile accidents during 1967.⁵ Also, in 1967, in excess of \$5.9 billion were expended on motor vehicle claims by casualty insurance firms.⁶ Deplorably, future earnings lost as a direct result of automobile fatalities exceeded \$5 billion during 1966.⁷ No modern industrial nation can indefinitely sustain indiscriminate decimation of its most precious resource--people--for any prolonged period.⁸

Prior to the Department of Transportation Act of 1966, federal transportation safety programs were perceived as being an administratively heterogeneous phenomenon.⁹ After the Act, however, safety management was approached on a homogeneous basis at the Secretarial and Administrative level of the organization, but was enforced as an unrelated subject at the intramodal, intraadministrative level. That is, the upper echelons of the Department managed all safety activities in an aggregate sense,

Federal Highway Safety Programs

whereas at the bureau level, safety programs were differentiated on the basis of mode of transportation.¹⁰

Federal statutes enforced by the Bureau of Highway Safety and the Bureau of Motor Carrier Safety, both of the Federal Highway Administration, constitute America's institutional approach to highway safety. Recently, however, Secretary of Transportation Volpe elevated the National Highway Safety Bureau to a modal operating administration and he is considering a similar recommendation for the Motor Carrier Safety Bureau.¹¹

The purpose of this paper is threefold. First, the functions performed by these two bureaus will be examined. Second, highway safety trends will be surveyed to see if the management of federal transportation programs represents a valid homogeneous function. Third, it will be determined whether activities performed by the National Highway Safety Administration and the Bureau of Motor Carrier Safety are organizationally amenable and can, therefore, more effectively reduce highway fatalities and injuries if housed within the Federal Highway Administration and the National Highway Safety Administration rather than within the Office of the Secretary.

FUNCTIONS OF THE BUREAU OF MOTOR CARRIER SAFETY

An original organizational component of the Federal Highway Administration, the Bureau of Motor Carrier Safety was established to enforce trucking laws previously administered by the independent Interstate Commerce Commission.¹² Principal safety responsibilities of the Bureau include: (1) inspecting records maintained by interstate motor carriers; (2) conducting periodic inspections of motor carrier vehicles either en route or on carrier's premises; (3) removing vehicles from service when found imminently hazardous; (4) investigating accidents; and (5) reporting violations.¹³ The agency's primary functions are essentially regulatory in composition and application.

Increased appropriations have been allocated to motor carrier safety but accidents and fatalities continue to increase annually. Although motor carrier safety programs are managed by an expert federal agency, there are three plausible explanations for the continued increases in trucking accident and fatality incidents. First, the profuse number of trucks precludes any virulent enforcement of safety laws: there are approximately 5.5 million trucks registered and operated domestically. Of this number, only 2.5 million fall within the jurisdictional purview of the Bureau of Motor Carrier Safety.¹⁴ Second, state safety laws, as they relate to trucking proper, vary extensively. This extreme variation circumvents any uniform, consistent approach to accident prevention at the vital state level.¹⁵ Third, financial and human resources devoted to trucking safety have been historically insufficient. On an aggregate basis, the ratio of federal safety outlays per trucking accidents is inordinately low when compared, for instance, to aviation accidents.¹⁶ Although expected results from motor carrier safety preventive programs have been less than optimal, trucking safety, as will be demonstrated in a subsequent section, is dissimilar managerially to that of automobile safety.

FUNCTIONS OF THE NATIONAL HIGHWAY SAFETY ADMINISTRATION

The genesis of federal interest in automobile safety dates back to 1926.¹⁷ Nevertheless, the establishment of one cogent, executive agency singularly responsible for auto safety was not achieved until the 89th Congress enacted the Highway Safety Act of 1966,¹⁸ and the National Traffic and Motor Vehicle Safety Act of 1966.¹⁹ Administered by the National Highway Safety Administration, both of these Acts are comprehensive and fundamentally provide for (1) promulgating uniform standards for the development of state highway safety programs; (2) maintaining a central drivers' register for suspended licenses; (3) establishing tire and motor vehicle safety standards for manufacturers; and (4) conducting safety research.²⁰ The Administration conducts its diverse activities through 16 offices.²¹ Furthermore, the macro-aspects of automobile safety, at this stage of the agency's program evolution,²² emphasize selected auto components rather than the total vehicle and the operator.

Confronted with rapidly accelerating automobile-inflicted deaths and injuries, the Administration's principal preventive programs have stressed equipment modification.²³ Moreover, through grant-in-aid programs, the agency is encouraging and facilitating state-developed supplementary safety programs. Even though the organization has concentrated its basic attention upon the vehicle proper, it is faced with two prodigious constraints, i.e., "how far to proceed with safety standards without depriving lower socio-economic groups of automobile ownership,"²⁴ and inadequate financial resources.²⁵

MACRO-FEATURES OF MOTOR VEHICLE SAFETY PROBLEMS

At the national level, the federal government lacks perspective in the almost ubiquitous area of highway safety, or the Department of Transportation is intrinsically aviation-safety oriented at the current expense of safety in other modes of transportation. In this regard, former President Johnson accurately surmized that inadequate resources had historically been allocated to highway safety programs in general.

Maximizing safety in all modes of transportation represents a major objective of the Department of Transportation. However, ample evidence exists that corroborates the widely held contention that the agency is basically aviation-safety oriented. This orientation, as previously indicated, is achieved at the expense of highway safety.

Table I depicts the absolute and relative magnitude of motor vehicle-related accidents for the period fiscal year 1966-1968. As noted, more than 102 million motor vehicles traveled upon America's streets and highways during fiscal year 1968.²⁶ Disastrously, 55,500 individuals were killed. However, as the number of drivers and population increases, death rates are decreasing in terms of registered vehicles. Four and a half million people were injured in 14.6 million accidents during fiscal year 1967.²⁷ Motor vehicle fatalities experienced during 1966 represented in excess of \$5 billion lost in future earnings.²⁸ During this year 1,374 individuals were killed in 5,132 accidents.²⁹

Federal Highway Safety Programs

Although only 155,000 aircraft utilized the federal airway system during the fiscal year 1968,³⁰ the Department of Transportation annually allocated almost \$1 billion to aviation safety programs, wherein only a small segment of the population is actively involved; but less than \$28 million for surface transportation safety activities--where every individual U.S. citizen is affected.³¹

TABLE 1. Principle facts about motor vehicle crashes in the United States, 1966-1968.

ITEM	1966	1967	1968 ¹
Deaths	53,041	53,100	55,500
Travel (billion vehicle miles)	930	970	1,010
Number of registered vehicles (millions)	96	100	102
Population	195,936,000	197,863,000	199,861,000
Number of drivers (millions)	101	103	106
Death rates:			
Per 100,000 population	27.2	26.8	27.8
Per hundred million vehicle miles	5.7	5.5	5.5
Per 10,000 registered vehicles	55.5	53.1	54.4

¹ Preliminary.

Sources: Compiled from U. S. Vital Statistics for 1966; National Safety Council, 1967; 1968 preliminary estimate by National Safety Council; vehicle travel, registered vehicles and drivers from Bureau of Public Roads, Department of Transportation Estimates; and midyear census forecasts.

Interestingly, when disaggregated and plotted on the basis of (1) age groups, (2) time of day, and (3) day of week, motor vehicle fatalities and accidents approximate normal distributions.³² In this regard, the mathematical probability is .95 that 68% of all fatal highway accidents will involve a person between 20 and 34 years of age, and the event will occur on Saturday between 8 p.m. and midnight.³³ These symmetrical distributions are statistically significant and are unique to

highway accidents and fatalities. If properly utilized, these distributions could be utilized to test the significance of a given hypothesis and thereby substantially reduce the serious constraint of limited resources that the National Highway Safety has. However, utilization of these data would necessitate a total re-orientation of the agency's present mechanical-engineering emphasis to one toward the humanistic aspects of highway safety.

IS TRANSPORTATION SAFETY MANAGEMENT INTERRELATED?

The maximization of safety in all modes of transportation was a major factor leading to the establishment of the Department of Transportation.³⁵ Prior to the Department's creation administration of federal safety transportation laws was perceived as unrelated activities. For instance, both the Federal Aviation Agency and the Civil Aeronautics Board were concerned with aviation safety, whereas the Interstate Commerce Commission and the U.S. Coast Guard were responsible for enforcing surface and maritime transportation safety laws, respectively. These dispersed programs stressed modally-oriented preventive programs. In this regard, transportation safety administration was viewed and practiced as being fundamentally unique to each of the several modes.

Aggregate management of federal safety programs is essentially a homogeneous phenomenon that will ameliorate only when approached on an intermodal basis. Indeed, at the macro-level numerous intermodal safety interfaces exist. In this sense, there can be no question but that effective preventive techniques developed in aviation, for instance, also have similar preventive application for motor carriers and maritime transportation.³⁷ Nevertheless, modal management should be grouped by function whenever possible. Furthermore, on a micro-basis, where the operating characteristics of the media involved can be clearly differentiated, then administration and organization should be discretely defined; not consolidated.

CONCLUSIONS AND RECOMMENDATIONS

Fundamentally, the Department of Transportation is aviation-safety oriented. Nevertheless, at the Secretarial level the agency manages safety on a unified basis. Also, highway safety emphasis is directed to the primary mechanical-engineering features of motor-vehicle equipment at present rather than toward the operator proper.

The Secretary of Transportation should refrain from consolidating the functions performed by the National Highway Safety Bureau and the Bureau of Motor Carrier Safety into one staff agency. The solution to highway safety problems is an adequate level of financial resources, not annual reorganizations of enforcement agencies. Furthermore, unless the Secretary is prepared to transfer all transportation safety program administration to his office, the National Highway Safety Administration should be transferred back to the Federal Highway Administration.

There are several logical justifications for concluding that functions performed by the National Safety Administration should be returned to the Federal Highway Administration and not co-mingled with those of the Bureau

Federal Highway Safety Programs

of Motor Carrier Safety. First, the Bureau of Motor Carrier Safety enforces laws that primarily embrace "for-hire" equipment that weighs from 10 to 20 tons. In other words, preventive techniques differ from auto-safety practices. Second, motor carrier safety involves inspections, qualification of drivers, and other regulatory factors not emphasized in automobile safety. Third, only 1.5 million, of a total population of 4 million trucks are subject to federal safety laws. However, all new and used automobiles beyond 1966 fall within the provisions of the National Highway Safety Act of 1966 and the National Traffic and Motor Vehicle Safety Act of 1966. Fourth, the two agencies should optimally be located in the Federal Highway Administration inasmuch as their preventive programs should be physically integrated with engineering-safety activities undertaken by the Bureau of Public Roads.³⁸

Safety in transportation has many interfaces and common preventive techniques. Reorganizations are not the answer to safety in general. The Department of Transportation's present institutional approach to safety is proper, and the agency should devote more resources to highway safety and not reorganize agencies at the upper echelons of the Department. The Office of Program Review already performs this function.

FOOTNOTES

¹U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States: 1968 (89th Ed.; Washington: U.S. Government Printing Office, 1968), p. 553.

²U.S. Congress, House, Message from the President of the United States Transmitting A Proposal for a Cabinet-Level Department of Transportation Consolidating Various Existing Transportation Agencies, H. Doc. 399, 89th Cong., 2d Sess., 1966, p. 54.

³*Ibid.*, p. 48. Although the former President alluded to numerous deficiencies that prevented meaningful and successful highway safety management, he concluded the principal causation was directly attributable to inadequate resources and a lack of intermodal priorities.

⁴Consult: U.S. Congress, House, Statement of the Honorable Charles Schultze, Director, Bureau of the Budget, Creating a Department of Transportation, Hearings, Before a subcommittee of the Committee on Government Operations, House of Representatives, on H.R. 13200, 89th Cong., 2d Sess., 1966, p. 54, where it was asserted that more financial resources should be devoted to highway safety programs.

⁵U.S. Department of Commerce, Statistical Abstract of the United States: 1968, *op. cit.*, p. 561.

⁶*Ibid.*, p. 555.

⁷U.S. Department of Transportation, Federal Highway Administration, First Annual Report to Congress on the Administration of the National Traffic and Motor Vehicle Safety Act of 1966 (Washington: U.S. Department of Transportation, March 1, 1968), p. 11.

⁸There exists a mathematical probability of .95 that at least 68 percent of all motor vehicle fatalities will occur in the age group 20 through 34. These fatalities are decimating this Nation's more precious resource--youth. In this regard, consult Erich W. Zimmerman, Introduction to World Resources (Ed. Henry Z. Hunker; New York: Harper and Row, 1964), p. 8, where Professor Zimmerman broadly defines resources as "an abstraction reflecting human appraisal and relating to a function or operation."

⁹Refer to U.S. Congress, Senate, Creating a Department of Transportation, and Other Purposes, S. 3010, 89th Cong., 2d Sess., 1966, and U.S. Congress, House, Creating a Department of Transportation, and Other Purposes, H.R. 13200, 89th Cong., 2d Sess., 1966, and the attendant hearing conducted before the Senate Committee on Government Operations. Throughout these extensive hearings, successive witnesses pointed out that separate agencies enforced safety laws for its respective mode of transportation. It was also pointed out that these organizations managed their respective programs autonomously and did not coordinate their safety activities with other involved agencies. For an example of problems associated with this lack of program coordination, consult Grant M. Davis, "Modifications in the Identifying Characteristics of Several Federal Transportation Activities," Transportation Journal, X., (Spring, 1970).

¹⁰Consult U.S. National Archives and Records Service, Organizations Manual of the U.S. Government: 1968-1969 (Washington: U.S. Government Printing Office, 1968), where the office of Program Review is depicted at the staff level reporting directly to the Secretary of Transportation. This executive office coordinates all programs and activities conducted by the Department of Transportation on an integrated and coordinated basis. Safety management at the operating administration level, however, is modally aligned: (1) Federal Highway Administration--Bureau of Motor Carrier Safety and National Highway Safety Bureau; (2) Federal Aviation Administration--entire agency concerned with safety; (3) Federal Railroad Administration--Bureau of Railroad Safety and Bureau of Pipeline Safety; (4) U.S. Coast Guard--operating divisions and search and rescue units.

¹¹"Motor vehicle men think differently than highway officials, and this has meant poor communications between the Highway Administration and Safety Bureau Officials..." Secretary Volpe feels that by transferring functions performed by the Bureau to his office, highway safety will be elevated. "Nixon Nominee as Chief of Auto Safety To Push for Traffic Death-Cut", The Wall Street Journal, (December 8, 1969) 81:7. Also, see "Safety Shift at DOT," Transport Topics, (December 15, 1969), 1792:10, where it is reported that opposition is developing against merging the functions of the National Highway Safety Bureau with those of the Bureau of Motor Carrier Safety. In fact, the American Trucking Association is pushing for a separate motor carrier administration within the Department, *Ibid*.

¹²For an exhaustive enumeration of federal trucking statutes relating to highway safety, refer to U.S. Congress, Public Law 89-640, 89th Cong., 2d Sess., 1966.

Federal Highway Safety Programs

¹³U.S. National Records and Archives Service, Organizational Manual of the U.S. Government: 1967-1968 (Washington: U.S. Government Printing Office, 1967), p. 408.

¹⁴See U.S. Department of Transportation, First Annual Report: Part I (Washington: U.S. Government Printing Office, November 26, 1968), p. 70, where it is stated that the Bureau of Motor Carrier Safety has jurisdiction over more than "250,000 trucks belonging to nearly 150,000 certified and private motor carriers." Also, consult Grant M. Davis, "One Way to Improve Trucking Safety," The Arizona Roadrunner, (April, 1969), 22:6-7, where the total number of trucks and carriers estimated to be exempt from federal safety statutes exceed "3 million vehicles and 250,000 carriers."

¹⁵U.S. National Records and Archives Service, *op. cit.*

¹⁶During fiscal year 1967, federal aviation safety outlays resulted in an expenditure ratio of approximately \$40:1 per accident. Highway safety expenditures, however, constitute an approximate ratio of \$2.80:1 per accident. These data compiled from: U.S. Bureau of the Budget, Budget of the United States Government for the Fiscal Year Ending June 30, 1969 (Washington: U.S. Government Printing Office, 1968), pp. 764-804, and U.S. Department of Transportation, First Annual Report: Parts I & II (Washington: U.S. Government Printing Office, 1968).

¹⁷The National Conference on Street and Highway Safety was opened by Secretary of Commerce Herbert Hoover in 1924. This Conference represents the start of federal interest in highway safety.

¹⁸U.S. Congress, Public Law 89-564, 89th Congress, 2d Sess. 1966.

¹⁹U.S. Congress, Public Law 89-563, 89th Congress, 2d Sess. 1966.

²⁰For an in-depth analysis of responsibilities and activities performed by the National Highway Safety Bureau, refer to: U.S. Department of Transportation, Federal Highway Administration, First Annual Report to Congress on Administration of the Highway Safety Act of 1966 (Washington: U.S. Department of Transportation, March 1, 1968). Also, see U.S. Congress, Senate, Committee on Commerce, Motor Vehicle Safety - 1969, Hearings, Before the Committee on Commerce, Senate, on S. 1245, 91st Congress, 1st Sess., 1969.

²¹U.S. Department of Transportation, First Annual Report: Part I, *op. cit.*, pp. 81-90.

²²Public Laws 89-563 and 89-564 are concerned with the total aspects of highway safety. However, original emphasis by the NHTSB has stressed vehicular components. In this regard, consult: "More Than Meets the Eye," The Phoenix Gazette, (December 10, 1969), 90:6; "Penalties Asked Against Four More Tire Firms for Failing to Meet U.S. Safety Standards," The Wall Street Journal, (December 1, 1969) 81:2; "Results of New Tests on Tires, Brake Safety are Issued by Agency," The Wall Street Journal (December 2, 1969) 81:14; *ad infinitum*.

²³*Ibid.*

²⁴Vigorous safety standards would increase total costs associated with producing a given automobile. The oligopolistic auto industry can shift these safety costs to the ultimate consumer in the form of higher product prices. Safety standards and costs, extended logically, can hypothetically exclude millions of lower socio-economic groups from automobile ownership. This exclusion would become particularly acute if standards were "back-dated" to cover automobiles produced before 1966.

²⁵See U.S. Bureau of the Budget, Budget of the United States Government for the Fiscal Year Ending June 30, 1969 (Washington: U.S. Government Printing Office, 1968), where it is shown that in 1969, \$41 million was allocated to surface transportation safety activities, and \$666.1 million for aviation safety per se. Significantly, this \$41 million is for automobile, motor-truck, railroad, maritime, and pipeline safety.

²⁶From Table I it can be seen that population increases geometrically but, fortunately, this phenomenon does not apply to highway fatalities and accidents.

²⁷U.S. National Transportation Safety Board, Second Annual Report to Congress: 1968 (Washington: U.S. Government Printing Office, 1968), p. 34.

²⁸U.S. Department of Transportation, First Annual Report to Congress on the Administration of the Highway Safety Act of 1966, *op. cit.*, p. 11.

²⁹See U.S. Department of Transportation, Federal Aviation Administration, Aviation Forecasts: Fiscal Years 1968-1969 (Washington: U.S. Department of Transportation, January, 1968), pp. 25-29; and U.S. Department of Transportation, First Annual Report: Part II (Washington: U.S. Government Printing Office, November 28, 1968), p. 59.

³⁰U.S. National Transportation Safety Board, Second Annual Report to Congress: 1968, *op. cit.*, p. 16. Interestingly, an inverse relationship exists between federal aviation safety expenditures and accident rates per million of passenger miles flown. That is, as expenditures increase, accident rates per million of miles flown decrease. The opposite holds true when outlays are reduced. For an extended discussion and analysis of this unique phenomenon, consult Grant M. Davis, The Department of Transportation-- An Instrument of National Transportation Policy (Unpublished Ph. D. Dissertation, University of Alabama, 1969), p. 304.

³¹Aggregate expenditures compiled from U.S. Bureau of the Budget, Budget of the United States Government for the Fiscal Year Ending June 30, 1969 (Washington: U.S. Government Printing Office, 1968), pp. 764-804.

Federal Highway Safety Programs

³² Axiomatically, any event, if repeated an infinite number of times, forms a normal distribution. Given a limited number of events, however, motor vehicle fatalities possess unique distribution that are statistically significant. For an excellent treatment of probability distributions and tests of hypothesis, refer to David V. Huntsberger, *Elements of Statistical Inference* (Boston: Allyn and Bacon, Inc., 1963), Ch. 5.

³³ Data compiled from U.S. Department of Transportation, First Annual Report to Congress on the Administration of the Highway Safety Act of 1966 (Washington: U.S. Department of Transportation, March 1, 1968), p. 11, and U.S. Department of Transportation, Bureau of the Census, Statistical Abstract of the United States: 1968 (89th Ed.; Washington: U.S. Government Printing Office, 1968), pp. 560-561.

³⁴ The presence of normal distributions associated with motor vehicle fatalities, injuries, and accidents can partially offset the serious constraint of limited financial resources. These distributions also increase in significance in view of the following statement by the National Transportation Safety Board: "The Board's surface transportation safety activities also has been seriously handicapped... employment of needed experts for the Highway Safety Division is 66 percent below congressionally approved manning authorization. The Bureau of Surface Transportation Safety must cover maritime, railroad, pipeline, and highway safety with a total of 11 professional people," Second Annual Report to Congress: 1968, *op. cit.*, p. 9. However, one bureau, the Bureau of Aviation Safety, is concerned solely with aviation safety matters.

³⁵ See Grant M. Davis, *The Department of Transportation* (Lexington, Mass.: D. C. Heath and Company, 1970), Ch. 4.

³⁶ In all instances, agencies enforcing federal safety programs pertaining to transportation always were aligned along modal lines even though programs were not always clearly differentiated.

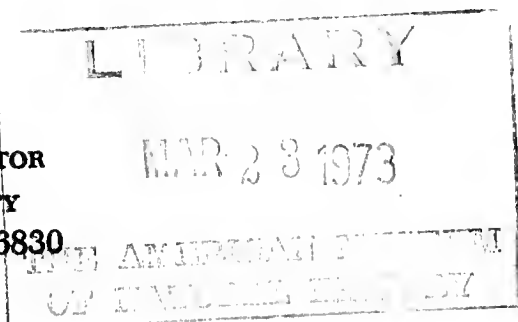
³⁷ Sophisticated statistical sampling techniques have been developed by the Federal Aviation Administration for inspecting aircraft components. These same techniques, together with management emphasis, have applications for other forms of transportation other than aviation. Also, the TOPICS programs managed by the Bureau of Public Roads also has managerial application to airport programs managed by the Federal Aviation Administration.

³⁸ There can be no question but that safety can be emphasized more if elevated organizationally to the Secretary's office. Logically, and pragmatically, it is unsound to move one safety agency to a staff position without elevating all safety functions. For an extensive analysis of "grouping organizations by function" consult: Charles L. Dearing and Winfred Owen, *National Transportation Policy* (Washington: The Brookings Institution, 1949), p. 464.

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830



THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

VOLUME 42

APRIL, 1971

NUMBER 2

EDITOR, PRO TEM.

Robert T. Gudauskas
Auburn University

ARCHIVIST

Clyde H. Cantrell
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman
Auburn University

Dan C. Holliman
Birmingham-Southern
College

Ann Everett
Crossville High
School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ARTICLES

- Grazing Incidence X-Ray Optical Systems
Stanley A. Fields 66
- Reflection Efficiency of Various Materials
at X-Ray Wavelengths
John M. Reynolds 73
- A Graphical Approach to Determine the Elastic
Deformation of Linear N-Phase Composite Solids
Michael R. A. Erdey 81
- Rectangular Diagram Approach to Determine The
Elastic Deformations of Non-Linear N-Phase
Composite Solids
Michael R. A. Erdey 94
- Some Problems of Estimating Strippable Coal
Reserves in Alabama
Reynold Q. Shotts 102
- Changes in Student Values During Two Years of
College
John W. Yeates 118
- A Survey of the Green Algae Inhabiting A Stream
in Mobile, Alabama
Margaret W. Miller 123
- Boron Deficiency Symptoms on *Hibiscus rosa-sinensis*
'Single Red'
Thomas Cochis, George H. Snyder, Kenneth E. Landers . . . 126

X-ray Optical Systems

GRAZING INCIDENCE X-RAY OPTICAL SYSTEMS

Stanley A. Fields
Marshall Space Flight Center
Huntsville, Alabama

INTRODUCTION

A new area of astronomy came into being in 1949 when Burnight (2) discovered that the sun emitted x-rays. Following this discovery, several groups studied the sun in the x-ray area of the spectrum using such instruments as pinhole cameras, scintillation detectors, proportional detectors and Geiger counters carried above the earth's atmosphere, first by balloons and rockets and later by satellites. In 1962, the first stellar x-ray source was discovered by Giacconi et al. (7) while attempting to detect fluorescence x-rays from the moon. It was determined that this source of x-ray emission originates outside the solar system in the direction of the constellation Scorpius. Later observations have confirmed the initial discovery of the stellar x-ray source and have identified at least 56 other sources (10).

The desire of scientists to study these x-ray-emitting sources in more detail has led to the study of grazing-incidence reflecting optics as a means of obtaining spatial as well as spectral information.

X-RAY OPTICS

The index of refraction of any material for x-rays is slightly less than unity. Simple classical dispersion theory shows the index of refraction to be

$$\mu = 1 - \delta, \quad (1)$$

where $\delta = ne^2 \lambda^2 / 2\pi mc^2$ in which n is the total number of electrons per unit volume; e , m , c , and λ are the electronic charge, the mass of the electron, the velocity of light and the wavelength, respectively (3). If the complementary angle of those in normal optics is used in Snell's law, as in Figure 1, then

$$\mu = \cos i / \cos r, \quad (2)$$

where i is the grazing angle of incidence measured in the less dense medium and r is the grazing angle of refraction. For an angle i_c and all smaller angles, x-rays incident on the more dense medium will be totally reflected in the less dense medium. In the limit $r = 0$; $\cos r = 1$, then

$$\mu = \cos i_c. \quad (3)$$

Combining Equations (1) and (3) gives

$$\cos i_c = 1 - \delta. \quad (4)$$

To a sufficient degree of approximation, $\cos i_c = 1 - i_c^2/2$, then

$$i_c = \sqrt{2} \delta . \quad (5)$$

X-ray microscopists were the first to become interested in the reflection and focusing of x-rays (4,9,11). In 1960, Giacconi and Rossi (6) described the design of an x-ray telescope consisting of one or several parabolic mirrors. Later in the year, Baez (1) described a telescope consisting of two thin plane-glass mirrors, each 1 x 3 in., disposed like the slats of a venetian blind, followed by an identical array at right angles to the first. A second telescope described by Baez, which was an improvement on the first, was made by curving the mirrors so that each one effectively becomes a section of a right circular cylinder. The concept of this telescope is shown by two of the mirror sections in Figure 2a. The successive reflections at the two mutually perpendicular cylindrical mirrors correct for the astigmatism. If only one of the mirrors were used, the image of point source 0 would result in a line, as in Figure 2b.

The paraboloidal mirror proposed by Giacconi and Rossi had the geometric property that paraxial rays will be imaged to a point at the focus of the paraboloid. However, it is not possible to satisfy the Abbé sine condition for any single reflection system at grazing incidence and the image will be subject to severe comatic aberration (8). Wolter (11) has shown that the aberration can be removed by the addition of a hyperboloid reflecting surface which is confocal and coaxial with the paraboloid. Wolter also showed that the Abbé sine condition can be satisfied more exactly by increasing the number of reflecting surfaces in multiples of two. Three general systems of the conic sections are shown in Figure 3 (8).

In March 1965, scientists from American Science and Engineering, Inc. (ASE) and the NASA-Goddard Space Flight Center launched a 7.6-cm-diam. grazing incidence telescope to observe the sun in the 8 to 12 Å region (5). The photographs obtained were the first solar photographs obtained at this wavelength region using grazing incidence optics. The mirror was electroformed nickel with the optics based on the work of Wolter. The resolution of the telescope for 8 Å radiation was measured to be better than 1 arc min before flight. One exposure of the sun taken with this telescope is shown in Figure 4a.

The Goddard Space Flight Center group launched two x-ray telescopes in May 1966 to photograph the sun in the 3 to 75 Å wavelength range (13). The two telescopes were 8 cm in diam. of the Wolter type and were made of 440C corrosion resistant steel. One photograph of the sun, which was fairly active, taken on this flight is shown in Figure 4b.

An x-ray telescope of the paraboloid and hyperboloid configuration was launched by ASE during a solar flare in June 1968 (14). The 22.5 cm diam. mirror had a kanigan-coated beryllium reflecting surface. Kanigen is a chemically deposited alloy consisting of 91% nickel and 9% phosphorus. The sun was moderately active on this date. The rocket was launched, acquired the sun 3 min. before the flare peaked, and observed the sun for 3 min. In the flare region, details 2 arc seconds in size could be distinguished in the original negatives (14). A photograph of the sun taken during this flight is shown in Figure 4c.

X-ray Optical Systems

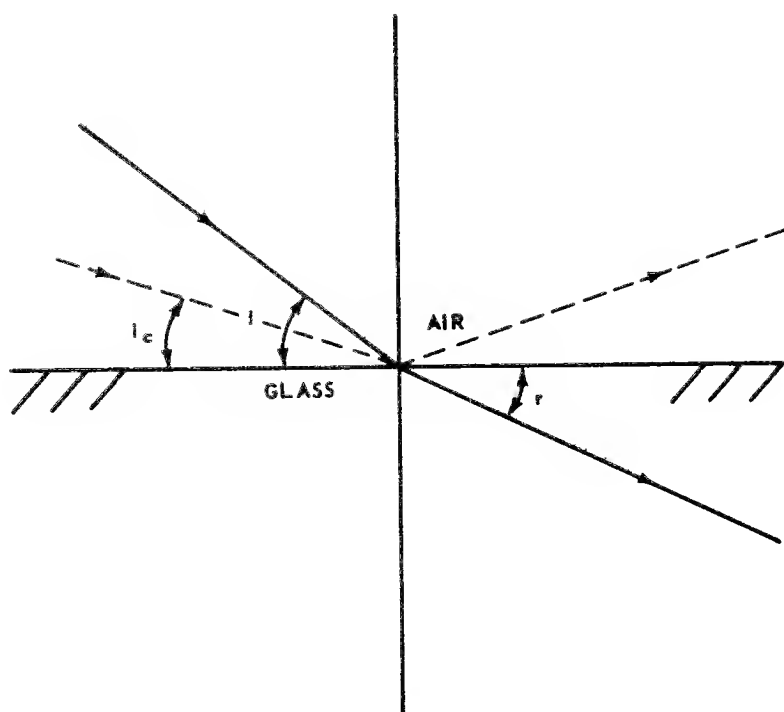


FIGURE 1. Total reflection of X-rays.

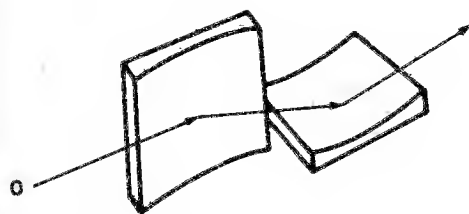


FIG 2a

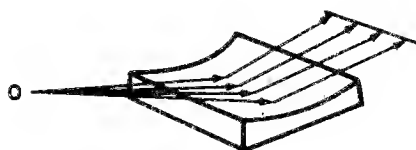


FIG 2b

FIGURE 2. Baez type optics.

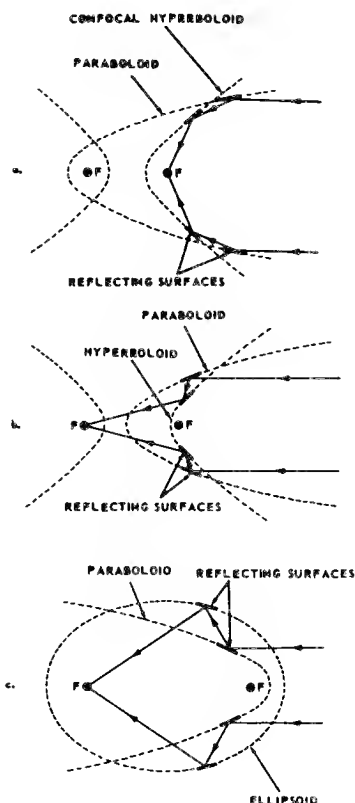


FIGURE 3. Three possible configurations for image-forming X-ray telescopes by Wolter.

The three photographs in Figure 4 show the improvement that has been made in the resolution of x-ray telescopes during their brief history. The photograph in Figure 4a has a resolution of about 1 arc min. The one in Figure 4b about 20 arc sec while the photograph in 4c is about 3 arc sec. Figure 4d is a photograph of the sun in $H\alpha$ light taken approximately 2 hr before the x-ray picture in Figure 4c. Note the correlation between the $H\alpha$ active regions and the x-ray emitting regions.

The 22.5 cm diameter mirror launched in June 1968 was the largest grazing incident telescope flown to date. Somewhat larger telescopes are being built for flight on the Apollo Telescope Mount (ATM). The ATM will contain two x-ray telescopes along with two ultraviolet experiments and a white light coronagraph.

One of the x-ray telescopes on the ATM will be a 22.5 cm diam. mirror and will obtain spatial and temporal distribution of x-ray sources over the solar disk and beyond the limb to approximately 1.5 solar radii in the 5-to 60-Å wavelength region (12). The other x-ray instrument consists of two coaxial mirrors of the paraboloid-hyperboloid configuration (Fig. 5). The inside diam. of the mirrors are approximately 22.9 and 30.5 cm. This instrument will obtain images of the x-ray flare events and obtain spectra over the range 2 to 10 Å.

A stellar x-ray program currently in the study phase is the High Energy Astronomy Observatory (HEAO). One of the payloads being studied

X-ray Optical Systems

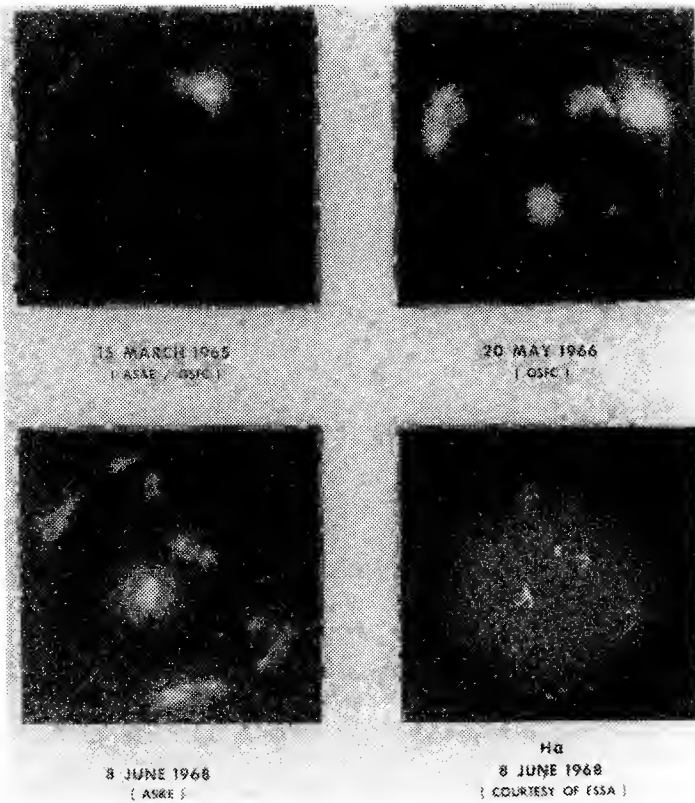


FIGURE 4. X-ray photographs of the sun using grazing incidence optics.

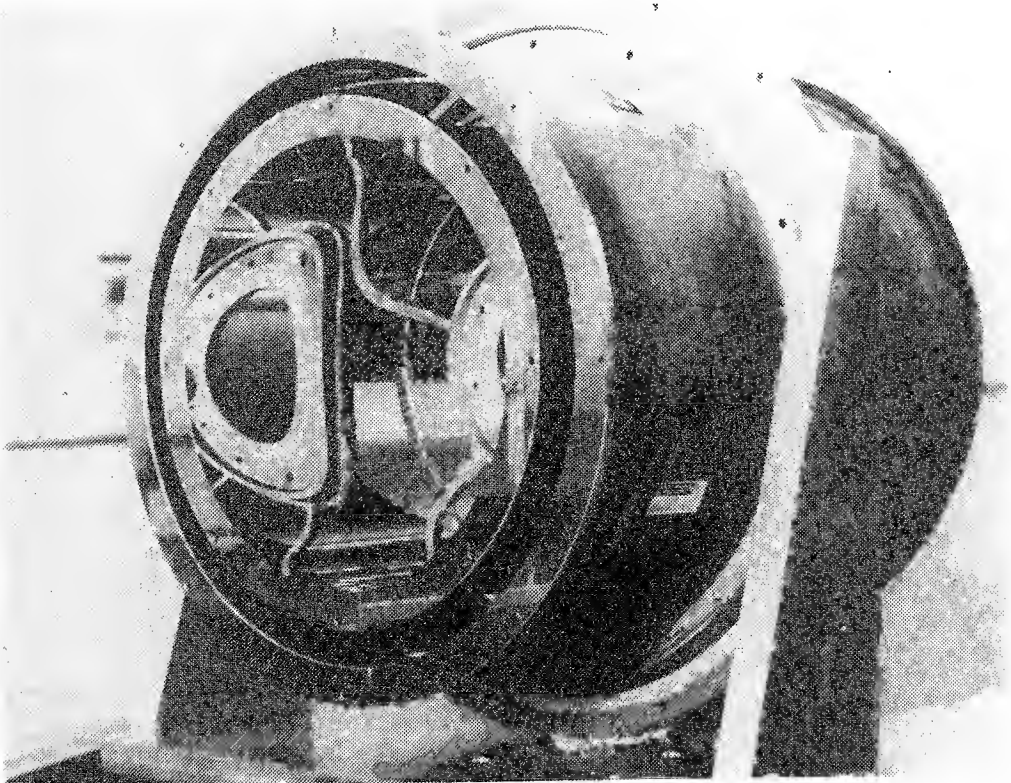


FIGURE 5. Apollo telescope mount S-054 X-ray mirror.

in this program contains two x-ray telescopes, a high-resolution mirror and a large area mirror. The high-resolution mirror is of the paraboloid-hyperboloid configuration. The telescope contains 5 concentric nested surfaces to increase the effective area of the telescope. This telescope will have approximately 1000-cm^2 collecting area with 1 arc sec resolution. The large collecting area mirror being studied is of the Baez configuration. This telescope will have approximately $5,000\text{-cm}^2$ collecting area and about 10 arc sec resolution.

SUMMARY

X-ray telescopes have been built with resolution of a few arc sec. The sun has been studied in the x-ray region of the spectrum using these optical systems which are lifted above the earth's atmosphere with rockets. The ATM program will permit long-time observations of the sun with an instrument with high spectral and spatial resolution.

Although at least 57 stellar x-ray sources have been identified, the resolution of instruments flown to date has limited the scientific results to little more than position locations. With an observational program such as HEAO, the source locations can be more precisely determined, polarization studies can be made and spectral lines identified. With this increased instrument sensitivity a lot more should be learned about the abundance of the elements in the stellar x-ray sources and the conditions in which they exist.

LITERATURE CITED

1. Baez, A. V. 1960. A proposed X-ray telescope for the 1 to 100 Å region. J. Geophys. Res. 65:3019-3020.
2. Burnight, T. R. 1949. Soft X-radiation in the upper atmosphere. Phys. Rev. 76:165.
3. Clark, G. L. 1963. The encyclopedia of X-rays and gamma rays. Reinhold Publishing Corp., New York.
4. Cosslett, V. E. and W. C. Nixon. 1960. X-ray microscopy. Cambridge University Press, New York.
5. Giacconi, R., W. P. Reidy, T. Zehnpfennig, J. C. Lindsay, and W. S. Muney. 1965. Solar X-ray images obtained using grazing incidence optics. Astrophys. J. 142:1274-1278.
6. Giacconi, R. and B. Rossi. 1960. A telescope for soft X-ray astronomy. J. Geophys. Res. 65:773-775.
7. Giacconi, R., H. Gursky, F. Paolini, and B. Rossi. 1962. Evidence for X-rays from sources outside the solar system. Phys. Rev. 9: 439-443.
8. Giacconi, R., W. P. Reidy, G. S. Vaiana, L. P. Van Speybroeck, and T. F. Zehnpfennig. 1969. Grazing incidence telescopes for X-ray astronomy. Space Sci. Rev. 9:3-57.

X-ray Optical Systems

9. McGee, J. F. 1959. An introduction to total reflection X-ray microscopy. *Advances in X-ray Analysis* 3:213-234.
10. Wilson, R. M., J. M. Reynolds, and S. A. Fields. 1969. A stellar X-ray astronomy summary and bibliography. NASA TMX 53952.
11. Wolter, H. 1952. Specular systems with grazing incidence as image optics for X-rays. *Ann. Physics* 10:94-114.
12. Scientific Experiments for the Apollo Telescope Mount. 1969. NASA TN D- 5020, March. Marshall Space Flight Center.
13. Underwood, J. H. and W. S. Muney. 1967. A glancing incidence solar telescope for the soft X-ray region. *Solar Physics* 1:129-144.
14. Vaiana, G. S., W. P. Reidy, T. Zehnpfennig, L. P. Van Speybroeck, and R. Giacconi. 1968. X-ray structures of the sun during the importance 1N flare of June 8, 1968. *Science* 161:564-567.

REFLECTION EFFICIENCY OF VARIOUS MATERIALS
AT X-RAY WAVELENGTHS

John M. Reynolds
Marshall Space Flight Center
Huntsville, Alabama

INTRODUCTION

The materials that may be used in the construction of an X-ray optical system are diverse according to the reflecting X-ray wavelength and the desired percentage of reflection. This report resulted from a literature search for experimental data relative to different materials with variation in X-ray wavelengths and the author's experimental data. Some of these materials were glass (3,8,10), quartz (5,7,10), beryllium (8), magnesium (4), aluminum (3,6,9), titanium (6,8), copper (9), silver (1,8), and gold (1,8,9). Apparently, most X-ray reflection experimental studies have been conducted on aluminum, glass, and gold. These three materials are used in this report to illustrate how the reflection efficiency changes with a change in wavelength. The X-ray wavelengths used for this comparison were from 1.54 Å to 114 Å. An effort was made to review papers that have reported the experimental reflection efficiency of optical flats in the X-ray region of the spectrum. Only a portion of the experimental results reported is used to represent the variance of reflection efficiency in the X-ray spectrum.

EXPERIMENTAL CONFIGURATION

The experimental configuration for studies of X-ray reflection from flat surfaces consisted of an X-ray source, adjustable slits to confine the radiation to the reflecting surface, a sample holder, and a detector system. Monochromatic radiation can be obtained by the addition of a crystal to this arrangement. The sample holder must be adjustable so that the angle between the sample surface and the incident radiation θ , may be varied. Figure 1 is a schematic of the experimental apparatus used by the author and others to study the reflection of X-rays.

The X-ray sources used were commercial fine-focus diffraction X-ray tubes. Adjustable optical slits were used to reduce the size of the X-ray beam and to confine it to the surface of the sample. The detectors consisted of a scintillation counter to measure the various components of the X-ray beam and photographic film to determine the initial angle of incidence and to check the alignment of the system.

EXPERIMENTAL PROCEDURE

The experimental procedure for measuring reflection efficiency of X-rays differs in detail for each experimenter. Nevertheless, each must determine the amount of radiation striking the mirror and the amount being reflected.

The slit arrangement shown in Figure 2A is one in which it is assumed that the incident X-ray beam is made up of a series of individual

X-ray Reflection Efficiency

rays. Slit S_1 is used to stop all rays from the source except X_1 , X_2 , and X_3 .

With the sample in position and the alignment complete, the sample holder was adjusted so that the sample made a small angle with respect to the incident radiation. Film was used as the detector to record X_1 , the direct radiation missing the sample, and X_R , the reflected radiation from the sample. Measurements taken from the photographic film were used to calculate the initial angle of incidence. The camera was replaced by the scintillation detector and slits S_2 and S_3 were adjusted. Slit S_2 was raised to block out all radiation striking below the surface of the optical flat (Fig. 2B). This adjustment of slit S_2 was accomplished by observing the total counts received by the detector in a given interval of time with the slit out of the X-ray beam. The slit was then raised until there was a very slight decrease in the total counts received. Thus, no radiation was striking the front edge of the optical flat. The third slit, S_3 , was now raised to block out X_1 , the radiation missing the sample to allow only the reflected radiation to strike the detector (Fig. 2C). The correct positioning of the slits could be checked at any time by replacing the scintillation detector with the camera. The slits and sample were thus in proper position for accumulation of X-ray reflection data.

The samples used in our experimental studies were quartz flats and nickel-coated quartz flats. The quartz flats were cleaned and stored in individual containers until measurements were made or until they were vacuum coated. An oil diffusion pump type vacuum system was used for the coating of the flats. The pressure of the system during deposition ranged from 9.0×10^{-6} Torr to 5.0×10^{-6} Torr. After deposition of the nickel on the substratum of quartz, the flats were immediately removed from the system and returned to their individual containers until the X-ray measurements were made.

SUBSTRATA AND THIN FILMS

Review of the literature indicated that most experimenters used a variety of glass for the deposition of the thin films. The X-ray reflection efficiency of glass generally remains relatively high. A comparison of the angle of incidence at the 25 and 50% reflection efficiency is given in Table 1. The shortest wavelength is 1.54 Å by Duncan and Parratt (3) on pyrex glass. The longer wavelength (113 Å) results used are those of Lukirskii and Savinov (6). For a reflection efficiency of 25%, the angle of incidence at the various wavelengths was: 1.54 Å - 0.20° , 8.32 Å - 0.5° , 16.0 Å - 1.65° , 31.4 Å - 3.95° , 44.6 Å - 5.20° , and 67 Å - 7.70° . Increasing the efficiency to 50% decreased the angle of incidence and the results were: 1.54 Å - 0.2° , 8.32 Å - 0.4° , 16 Å - 0.95° , 31.4 Å - 2.5° , 44.6 Å - 4.1° , 67 Å - 5.3° , and 113 Å - 7.95° . At the 75% reflection efficiency, the total angle of incidence for all wavelengths was greatly reduced. The range is 0.2° at 1.54 Å to 2.75° at 113 Å. Thus, for a high reflection efficiency, the effective angle of incidence was rather small (Fig. 3).

With the X-ray reflection efficiency of the substrate determined, one may vapor deposit a material on the glass to increase the efficiency and/or the angle of incidence. The materials chosen as examples were aluminum ($Z = 13$) and gold ($z = 79$).

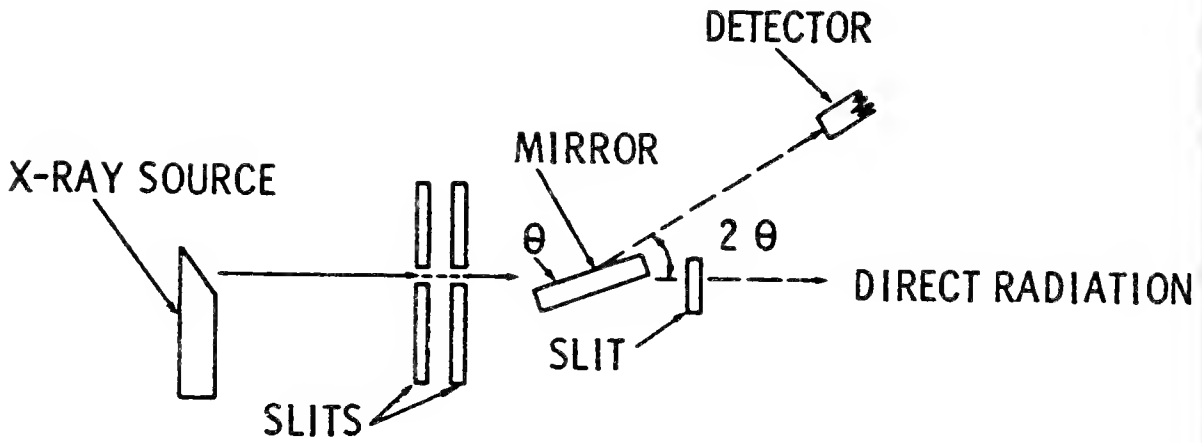


FIGURE 1. Schematic of experimental apparatus.

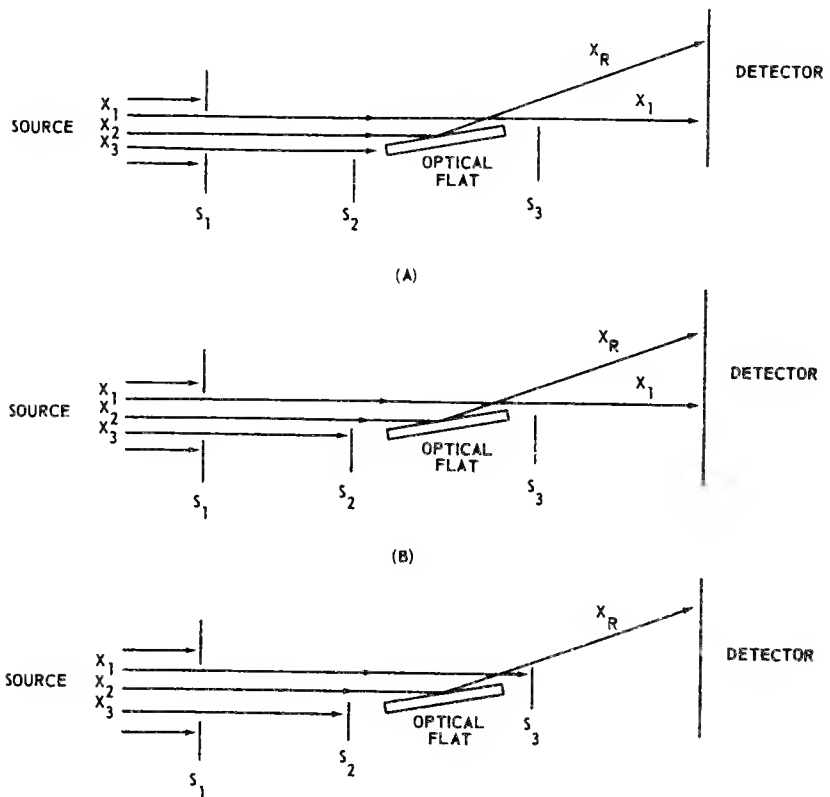


FIGURE 2. Optical slit arrangement.

X-ray Reflection Efficiency

TABLE 1. A comparison of wavelengths and angles of incidence.

X-ray reflection efficiency (1%)	(A)	Angle of incidence (°)		
		Glass ¹	Al (z = 13) ²	Au (z = 79) ³
25	1.54	0.2	0.22	0.60
	8.32	0.5	1.17	2.0
	16.0	1.65		
	23.6			4.0
	31.4	3.95	4.5	
	44.6	5.20	5.5	6.0
	67.0	7.70	7.7	8.8
	113.0		8.0	
	114.0			20.0
50	1.54	0.2	0.21	0.45
	8.32	0.4	1.08	1.50
	16.0	0.95		
	23.6		3.00	2.20
	31.4	2.5	3.6	
	44.6	4.1	3.5	4.20
	67.0	5.3	4.8	8.00
	113.0	7.95	4.5	13.60

¹From (3,4,5,6,10; Fig. 3)

²From (3,4,5,6; Fig. 4)

³From (4,5,6,8; Fig. 5)

Aluminum has a rather low atomic number but exhibits relatively good X-ray reflection characteristics (Fig. 4). For an efficiency of 25%, the angle of incidence for the various wavelengths was: 1.54 Å - 0.22°, 8.32 Å - 1.17°, 31.4 Å - 4.5°, 44.6 Å - 5.5°, 67 Å - 7.7° and 113 Å - 8.0°. From these figures, one can see that upon addition of a reflecting film deposited on substrata, the angle of incidence was increased. Increasing the X-ray reflection to 50%, one finds: 1.54 Å - 0.21°, 8.32 Å - 1.08°, 23.6 Å - 3.0°, and 31.4 Å - 3.6°. As the angle of incidence was increased the angle actually decreased below glass because of the absorption of the aluminum. Upon increasing the efficiency to 75%, the angle of incidence was reduced to 0.22° at 1.54 Å and to 2.6° at 113 Å, which is about the same as the glass substrata with no thin film deposit.

Choosing a material of high atomic number, such as gold (z = 79), the angle of incidence was increased at all X-ray reflection efficiencies (Fig. 5). For an X-ray reflection efficiency of 25%, the values were:

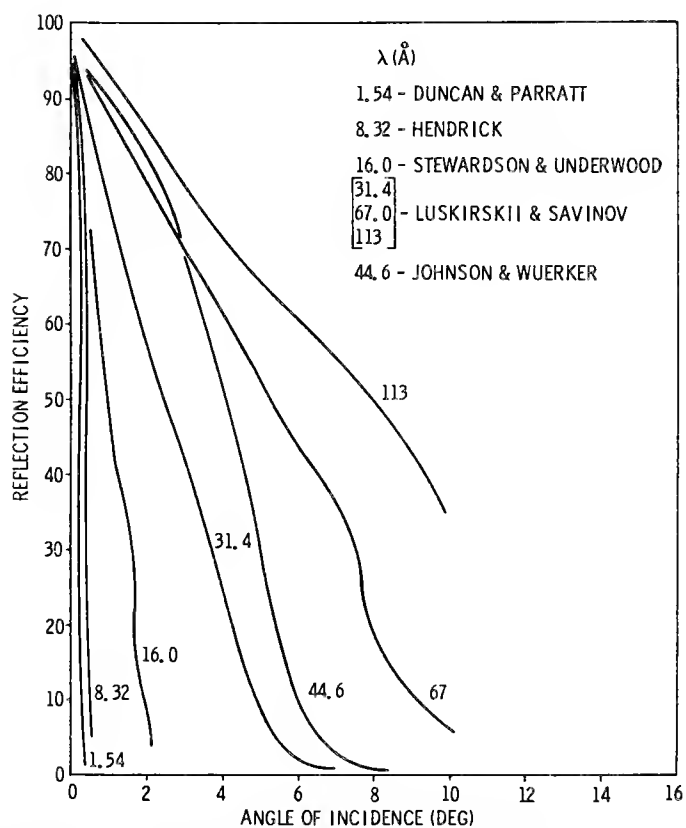


FIGURE 3. Reflection efficiency curves of glass.

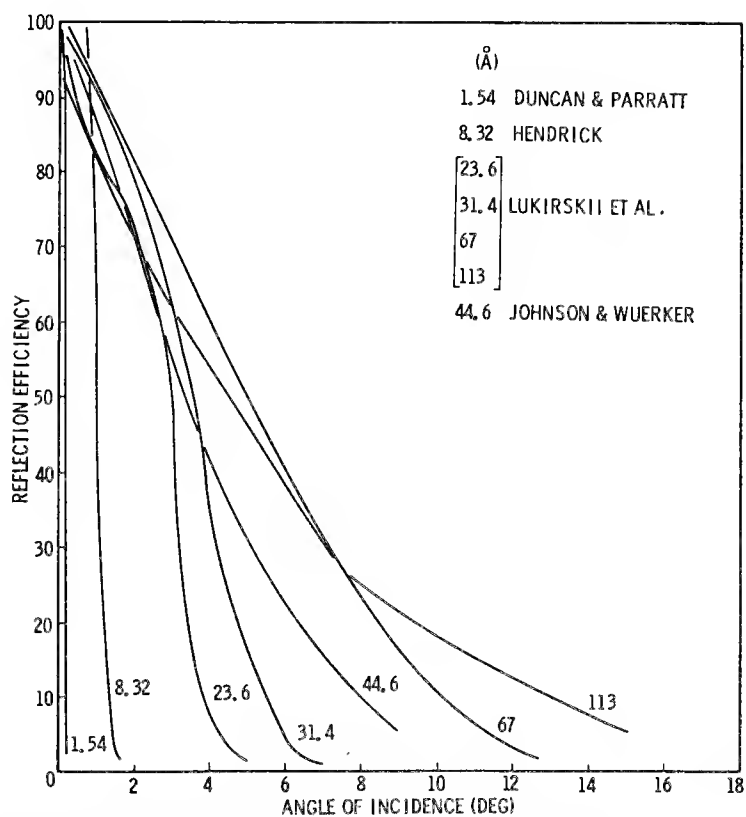


FIGURE 4. Reflection efficiency curves of aluminum

X-ray Reflection Efficiency

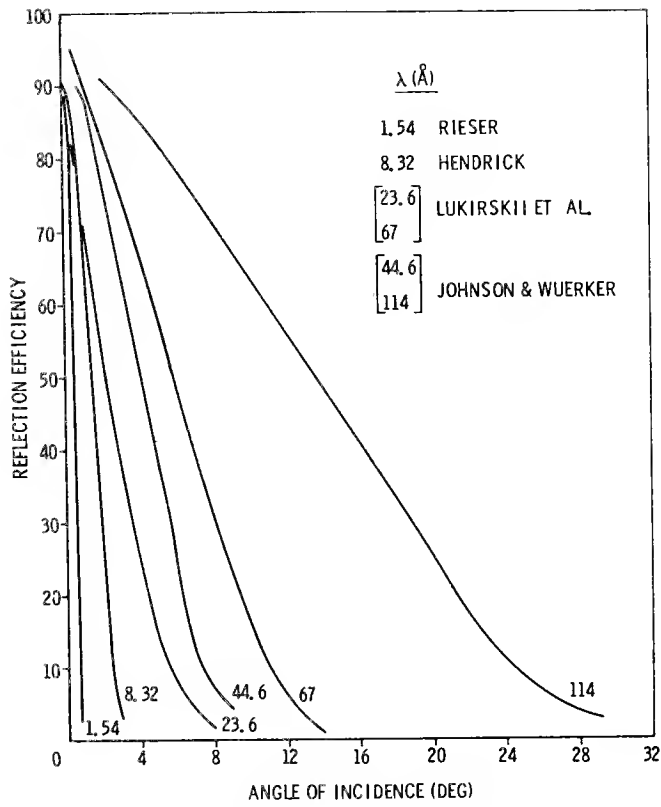


FIGURE 5. Reflection efficiency curves of gold.

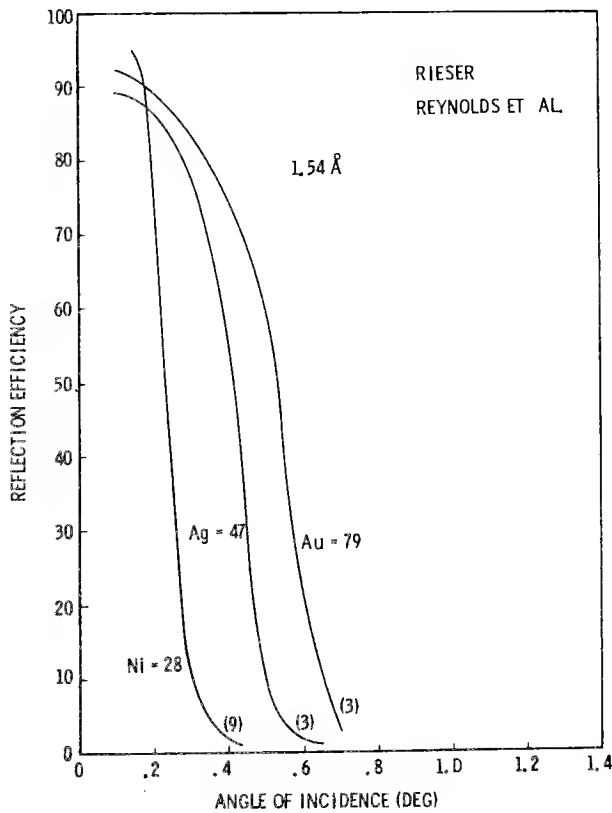


FIGURE 6. Reflection efficiency curves of nickel, silver, and gold.

1.54 Å - 0.60°, 8.32 Å - 2.0°, 23.6 Å - 4.0°, 44.6 Å - 6°, 67 Å - 8.8°, and 114 Å - 20.0°. Upon increasing the efficiency to 50%, the results were: 1.54 Å - 0.45°, 8.32 Å - 1.50°, 23.6 Å - 2.20°, 44.6 Å - 4.20°, 67 Å - 8.00° and 113 Å - 13.60°.

Another example of variation in angle of incidence for a wavelength of 1.54 Å is given in Figure 6. The three reflecting media were nickel ($z = 28$), silver ($z = 47$), and gold ($z = 79$). In this example, the angle of incidence was increased as the atomic number of the reflecting medium is increased. This is true up to an efficiency of 85%.

SUMMARY

The materials that may be used for construction of an X-ray optical system are varied. The lower X-ray wavelengths in combination with a reflecting medium of low atomic number will give a relatively high reflection efficiency but the angle of incidence will be small and not extended over a very great range. With an increase in wavelength and a reflecting medium of increasing atomic number the angle of incidence will be greater.

These are some of the parameters to be considered in constructing an X-ray optical system for solar and stellar X-ray astronomy.

LITERATURE CITED

1. Cosslett, V. E. and W. C. Nixon. 1960. X-ray microscopy. Cambridge University Press, New York.
2. Dershem, E. and M. Schein. 1931. The reflection of the K α line of carbon from quartz and its relationship to index of refraction and absorption coefficient. Phys. Rev. 37:1246-1251.
3. Duncan, R. C. and L. G. Parratt. 1958. A study of evaporated aluminum films by X-ray total reflection. AFOSR-TN-58-680, ASTIA AD 162-212, Technical Report No. 13.
4. Hendrick, R. W. 1957. Spectral reflectance of solids for aluminum K radiation. J. Opt. Soc. Am. 47:165-171.
5. Johnson, G. L. and R. F. Wuerker. 1963. Reflectance measurements at carbon-K and beryllium-K wavelengths. In X-ray Optics and X-ray Microanalysis, W. H. Pattee, V. E. Cosslett, and A. Engstrom, Eds., Academic Press, New York and London.
6. Lukirskii, A. P. and E. P. Savinov. 1963. Reflection of ultra-soft X-radiation from glass and titanated surfaces. Opt. Spectry. 14:152-154.
7. Reynolds, J. M., S. A. Fields, and R. M. Wilson. 1969. X-ray reflection of nickel-coated quartz optical flats. Marshall Space Flight Center Internal Note, IN-SSL-T-69-9.

X-ray Reflection Efficiency

8. Rieser, L. M., Jr. 1957. Reflection of X-rays from condensed metal films. J. Opt. Soc. Am. 47:987-994.
9. Scott, N. J. 1957. Study of thin vacuum deposited copper films by X-ray total reflection. AFOSR-TN-57-779, ASTIA AD 148 010, Technical Report No. 11.
10. Stewardson, E. A. and J. W. Underwood. 1965. The reflection of soft X-rays by polished surfaces of glass and steel. Brit. J. Appl. Phys. 16:1877-1884.

A GRAPHICAL APPROACH TO DETERMINE THE ELASTIC DEFORMATION
OF LINEAR N-PHASE COMPOSITE SOLIDS

Michael R. A. Erdey
Electrical Engineering Department
Tuskegee Institute, Alabama

INTRODUCTION

Recently (4,6), the model approach to two-phase composite solids was discussed with the aid of various models wherein only the laminated models generalizing the technique to n-phase linear composite solids were used. Also, only the analysis part of the problem was exposed; the modulus of elasticity of the composite material was found from the moduli of elasticity of the composite material and their blending proportions.

In this paper, the synthesis problem is attacked; the modulus of elasticity of the required composite material is given along with the moduli of elasticity of the component materials. The unknowns are the blending ratios of the component materials that have to be found.

There is a unique solution, in the synthesis problem for two materials, but the formulae in the combined cases are quite complicated. There is no unique solution to the problem of the n-phase case and much freedom is left to the designer to introduce additional constraints for economy or other bases. In problems where much flexibility is left to the designer, graphical techniques are very advantageous since the best natural optimizer is the human eye.

For all $n \geq 3$ cases, the same graphical technique is used.

The Laminated Models

Laminated Models represent certain simplifying assumptions. If the internal structure of a material is such that the strain is the same over any section of the composite material while stresses in the phases are proportional to the moduli of elasticity of the phases, we can represent the composite material with the laminated model of Figure 1. In this case,

$$E_a = g_1 E_1 + g_2 E_2 + \dots + g_k E_k + \dots + g_n E_n \quad (1)$$

where E_a = modulus of elasticity of the composite material, E_k = modulus of elasticity of the k-th phase, and g_k = fractional volume of particles (percent/100).

Hereafter, this model will be referred to as the "arithmetic mean" model since E_a is obtained by weighted arithmetic mean; subscript a refers to this also.

Another simple model is obtained if it is assumed that the stress

A Graphical Approach

is the same over any section of the composite material while the deformations of the phases are inversely proportional to the moduli of elasticity of the phases. This can be represented with the laminated model of Figure 2 and described by

$$\frac{1}{E_h} = \frac{g_1}{E_1} + \frac{g_2}{E_2} + \text{----} + \frac{g_k}{E_k} + \text{----} + \frac{g_n}{E_n} \quad (2)$$

This model will be referred to as the "harmonic mean" model reminding us that E_h is obtained as a harmonic mean; subscript h refers to the same fact.

In both cases, the following interrelation holds:

$$g_1 + g_2 + g_3 + \text{----} + g_n = 1 \quad (3)$$

Both models can be represented with their electrical equivalents. E_k can be replaced by the R_k resistance of a rheostat and the g_k blending ratio can be represented by the length proportion between the sliding arms of the pertinent rheostat. In this analog equation, (1) can be represented with the series connected rheostat sections of Figure 3-a. Instead of rheostats, we could represent equation (1) with the series connected resistors of Figure 3-b. Similarly, equation (2) can be represented with the parallel connected resistors of Figure 4. Instead of rheostats or resistors, we could have chosen variable inductors or fixed inductors with the same interconnection pattern.

The reader is reminded that a series interconnection corresponds to the parallel laminations of Figure 1 in the electrical analog of Figure 3-b. In a similar way, the electric analog of the series laminations of Figure 2 are the parallel connected resistors of Figure 4. This is the consequence of the inverse analogy used. If we had replaced E_k with a G_k conductance, direct analog would have been obtained showing the same type of patterns between the laminations and the interconnection pattern of the pertinent conductances. Mechanical analogs could have been chosen with series or parallel connected springs to represent the laminated model instead of electrical network analogs.

It has been pointed out (5) that E_a represents an upper bound for the modulus of elasticity of the composite material, while E_h gives a lower bound for the modulus of elasticity. Therefore, a better approximation is obtained if E_a and E_h are further combined.

$$E_A = \frac{E_a + E_h}{2} \quad (4)$$

Equation (4) will be a better approximation when there is a continuous phase with one of the higher E materials, while the other phases are dispersed in it. On the other hand, if the continuous phase has one of the lower E values, a better approximation in the form of equation (5) is obtained.

$$\frac{1}{E_H} = \frac{0.5}{E_a} + \frac{0.5}{E_h} \quad (5)$$

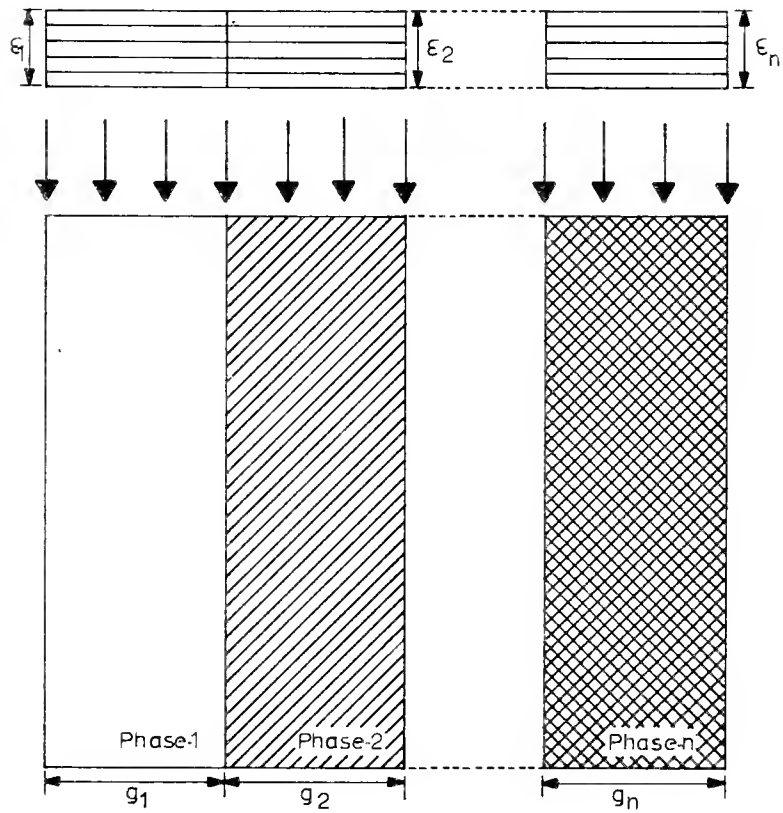


FIGURE 1.

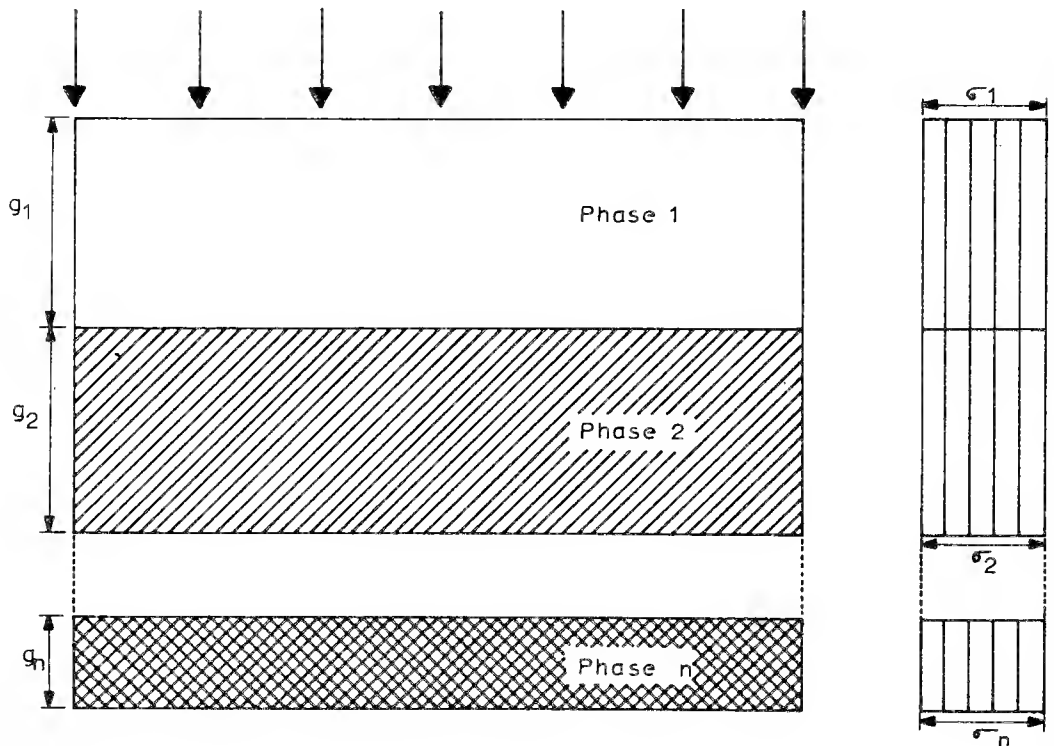


FIGURE 2.

A Graphical Approach

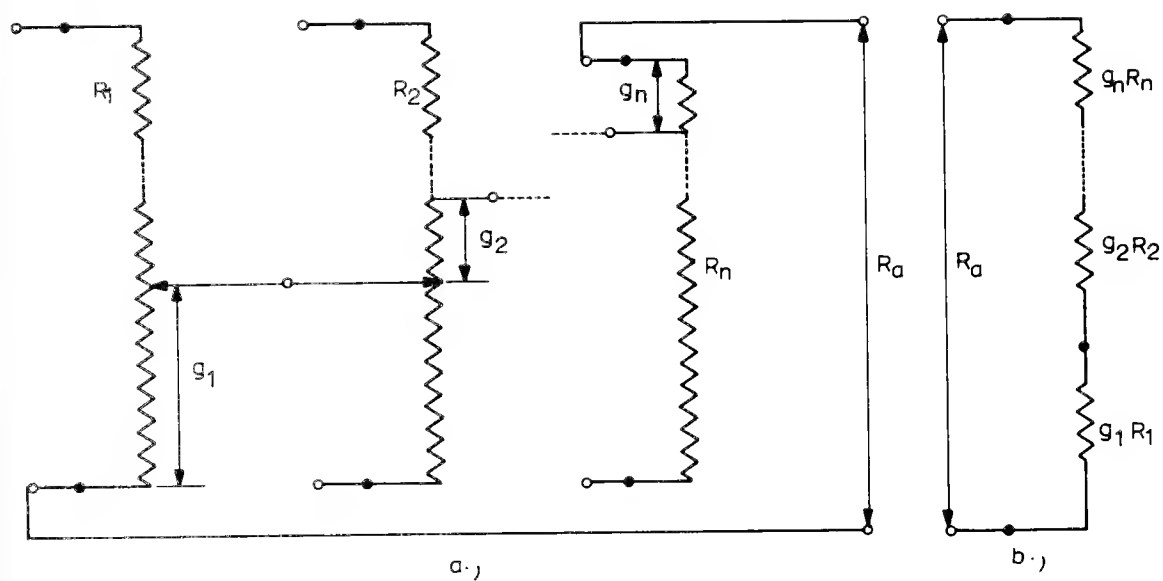


FIGURE 3.

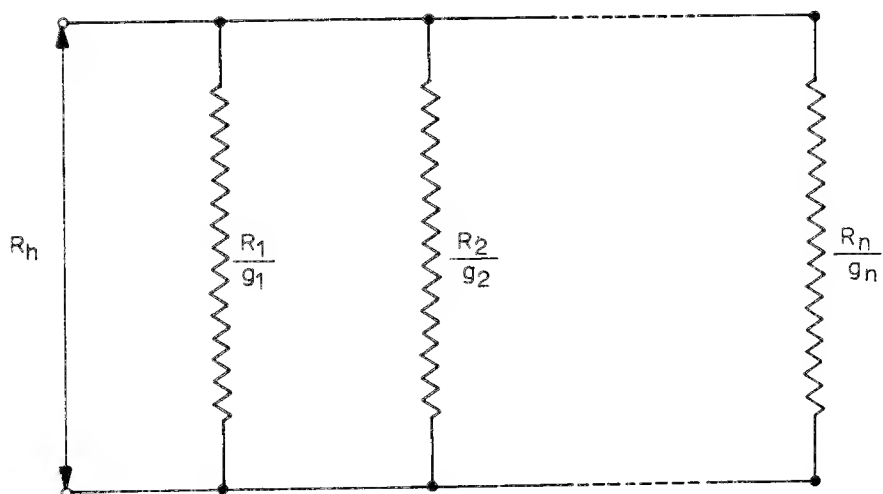


FIGURE 4.

Therefore, equation (4) will be referred to as the "composite hard" model and equation (5) as the "composite soft" model. The laminated models of the "composite hard" and "composite soft" models can be found in Figure 5-a and b; their resistive network models are given in Figure 6-a and b.

To handle the problem in a convenient graphical form, equation (1) is rewritten in the form of equation (6)

$$E_a = E_n + (g_1 + g_2 + \dots + g_{n-1})(E_{n-1} - E_n) + (g_1 + g_2 + \dots + g_{n-2})(E_{n-2} - E_{n-1}) + \dots + g_1(E_1 - E_2)$$

assuming that subscripts were chosen in such a way that $E_1 > E_2 > \dots > E_{n-1} > E_n$ relation is satisfied. If the following substitutions are made in equation (2)

$$\frac{g_1}{E_1} = \frac{\chi_2}{E_2}, \quad \frac{g_2 + \chi_2}{E_2} = \frac{\chi_3}{E_3}, \quad \dots, \quad \frac{g_{n-2} + \chi_{n-2}}{E_{n-2}} = \frac{\chi_{n-1}}{E_{n-1}}, \quad \frac{g_{n-1} + \chi_{n-1}}{E_{n-1}} = \frac{\chi_n}{E_n}$$

then we obtain equation (7)

$$\frac{1}{E_h} = \frac{g_n + \chi_n}{E_n}$$

In the case of $n = 4$, equation (6) and (7) and the substitutions are:

$$E_a = E_4 + (g_1 + g_2 + g_3)(E_3 - E_4) + (g_1 + g_2)(E_2 - E_3) + g_1(E_1 - E_2) \quad (8)$$

$$\frac{g_1}{E_1} = \frac{\chi_2}{E_2}, \quad \frac{g_2 + \chi_2}{E_2} = \frac{\chi_3}{E_3}, \quad \frac{g_3 + \chi_3}{E_3} = \frac{\chi_4}{E_4}$$

$$\frac{1}{E_h} = \frac{g_4 + \chi_4}{E_4} \quad (9)$$

These interrelations for a particular E_1, E_2, E_3, E_4 set are graphically given in Figure 7. Note that the magnitudes of all E 's are between 0 and 1 which are allowed if the same power of 10 is factored out everywhere and taken into account at the end of the procedure.

The constructions in Figure 7 are basically very simple. Point 0 is interconnected on the right with E_1, E_2, E_3 and E_4 . At the left, E_1 is interconnected with Q_1 (end of g_1 interval). The intersection of $\overline{E_1 Q_1}$ with the horizontal line at E_2 level gives Q_4 . Similarly, $\overline{Q_4 Q_2}$ (where Q_2 is at the end of the g_2 interval) intersects with the E_3 level at Q_5 . Repeating the process with $\overline{Q_5 Q_3}$ we obtain Q_6 . Dropping vertical lines from Q_4, Q_5 and Q_6 to the base and notating their intersections with the base and the horizontal lines at E_3 and E_4 levels we obtain Q_7, Q_8, Q_9, Q_{10} and Q_{11} points. And thus, we have the basic framework for the graphical evaluation of E_a and E_h .

A Graphical Approach

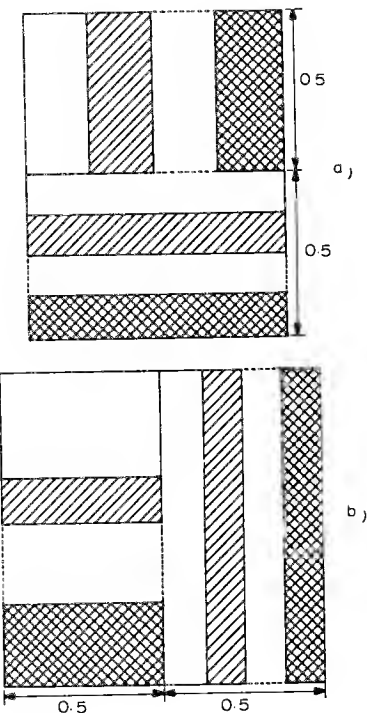


FIGURE 5.

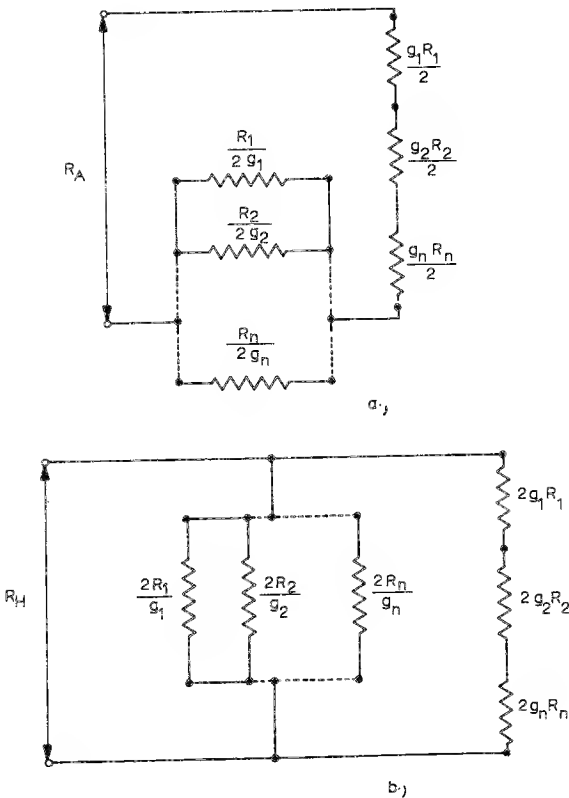


FIGURE 6.

First, let us generate E_a . Since the E_4 height is already given, we have to generate $(g_1 + g_2 + g_3)(E_3 - E_4)$, but this is equal to $\overline{P_8P_9} = \overline{P_{11}E_4}$. Similarly, $(g_1 + g_2)(E_2 - E_3)$ is equal to $\overline{P_4P_5} = \overline{P_{10}P_{11}}$ and finally $g_1(E_1 - E_2)$ is equal to $\overline{P_1P_2} = \overline{E_aP_{10}}$. And thus,

$$E_a = E_4 + \overline{P_{11}E_4} + \overline{P_{10}P_{11}} + \overline{E_aP_{10}} \quad (10)$$

The reader can see that E_a could be obtained if we draw from point P_1 (the point obtained by the intersection of the vertical line drawn from Q_1 with $\overline{OE_1}$) a parallel line to $\overline{OE_2}$. Where this line intersects the vertical drawn from Q_2 we obtain P_2 . From P_2 we draw parallel to $\overline{OE_3}$ which will intersect the vertical from Q_3 at P_6 . Finally, the parallel line drawn from P_6 to $\overline{OE_4}$ intersects the right boundary at E_a .

The substitution interrelations can be obtained from similar triangles as follows:

$$\frac{g_1}{E_1} = \frac{\chi_2}{E_2} \text{ from } O \ Q_1 \ E_1 \ \Delta \sim \ Q_7 \ Q_1 \ Q_4$$

$$\frac{g_2 + \chi_2}{E_2} = \frac{\chi_3}{E_3} \text{ from } Q_7 \ Q_2 \ Q_4 \ \Delta \sim \ Q_8 \ Q_2 \ Q_5 \ \Delta$$

$$\frac{g_3 + \chi_3}{E_3} = \frac{\chi_4}{E_4} \text{ from } Q_8 \ Q_3 \ Q_5 \ \Delta \sim \ Q_{11} \ Q_6 \ Q_5 \ \Delta$$

Drawing a line through points 1 and Q_6 at the intersection with the left boundary gives E_h , which can be verified from equation (9), again with a pair of similar triangles

$$\text{since } \frac{1}{E_h} = \frac{g_4 + \chi_4}{E_4} \text{ can be seen from } O1 \ E_h \ \Delta \sim \ Q_g \ 1 \ Q_6 \ \Delta$$

Now that we have both E_a and E_h , we can find E_A and E_H . Since E_a is just the arithmetic mean of E_a and E_h on the right boundary, we just halved $\overline{E_aE_h}$. E_H is found with the harmonic mean process with the two dotted lines. The previous Q_6 point was this time replaced by point R.

In the general n-phase case of equations (6) and (7), the process is exactly the same. The E_1 to E_n points on the right are interconnected with point O. On the left, similar to the four E_1, Q_4, Q_5, Q_6 points with a similar process a set of n points are generated on the levels of the pertinent $E_1 - E_n$ points. When E_a and E_h are obtained, E_A and E_H are obtained with exactly the same process that we have seen in Figure 7.

A Graphical Approach

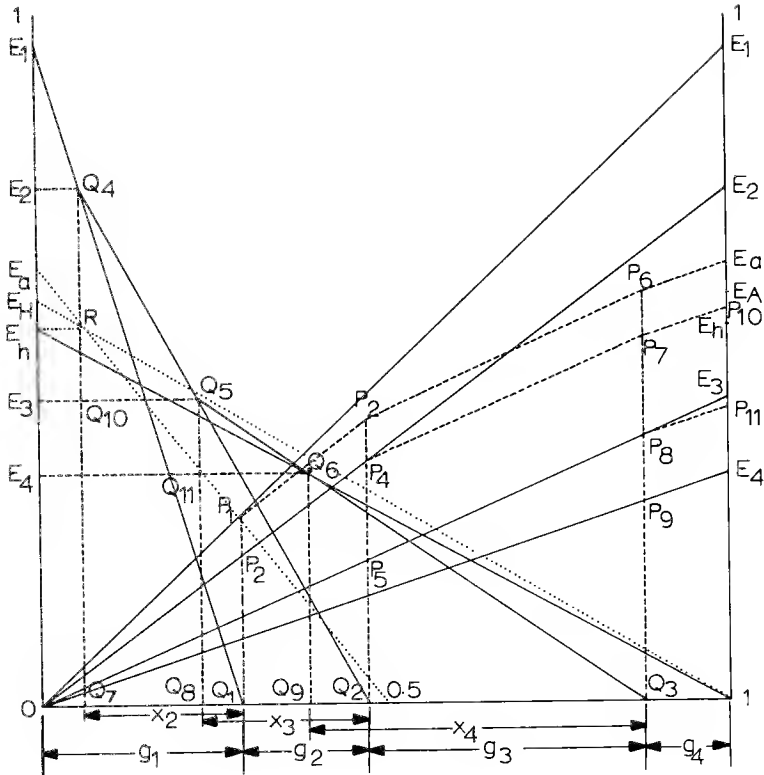


FIGURE 7.

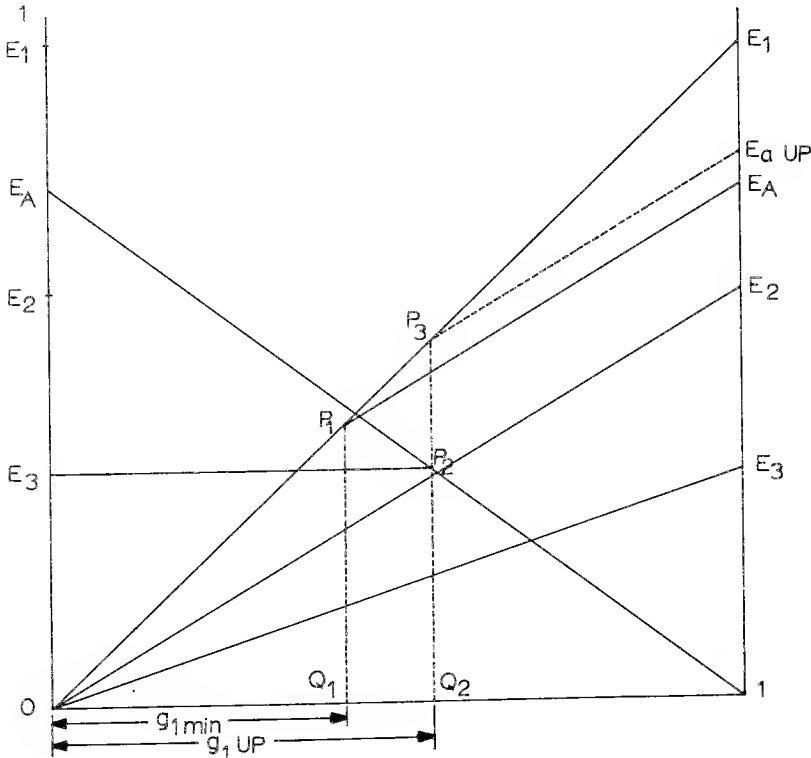


FIGURE 8.

The technique was demonstrated in the analysis problem to familiarize the reader with it. Since combinations only of arithmetic and harmonic means were involved, there was no need to introduce graphical techniques. However, the synthesis problem becomes quite complex analytically and requires introduction of graphical techniques.

The Synthesis Problem

In the synthesis problem, it is assumed that $E_1, E_2 \dots E_n$ and either E_A or E_H are given if a composite soft case is assumed and the problem is to find the $g_1, g_2 \dots g_n$ blending ratios.

In case of only two components, the solution is unique (7), but the uniqueness is not satisfied for the $n-2$ cases. For these, additional $n-2$ parameters can be varied within reasonable limits, and this is where the graphical approach will be helpful.

Let us assume that we have a 3-phase problem where E_1, E_2, E_3 and E_A are given a particular set of these values as in Figure 8. In addition, one parameter can be chosen freely within allowable limits; we choose freely g_1 . We can see that the smallest value of g_1 is obtained if $E_a = E_A$ and $g_3 = 0$. Graphically, this condition is equivalent of drawing a parallel to $\overline{0 E_2}$ through E_A . This line intersects $\overline{0 E_1}$ in P_1 from where the min value of g_1 is obtained by dropping a perpendicular to the base. The intersection of $\overline{E_H 1}$ with the E_3 level will be further to the right if E_H is larger. The maximum value of $E_H = E_A$. In this case, the intersection point is point P_2 . Since this point is always to the right of the right end of the pertinent g_1 , interval $\overline{0 Q_2}$ gives only an upper bound to g_1 . Since for any g_1 the maximum value of E_a is obtained by letting $g_3 = 0$, the parallel line to $\overline{0 E_2}$ through point P_3 defines the upper bound for E_a .

The conditions in Figure 8 were given such that the allowable range for either g_1 or E_a was quite small. In Figure 9, we have a case for a 3-phase problem where the allowable range for both g_1 and E_a is larger. Since it is obvious that larger proportions from the higher values of E 's will increase the value of E_a and since it is well known that the human eye is the best optimizer if graphical displays are available, the designer can easily choose the most desirable solution at a glance after a little practice.

In Figure 9, E_A is chosen almost equal to E_2 . This is done to stress how rapidly the solution can be seen at the beginning if we approach it from the heuristic point of view. Therefore, E_1 and E_3 will almost serve to compensate each other. If we take a larger proportion of them, a smaller proportion of E_2 will remain. A larger proportion E_1 will mean a larger E_a . Thus, the intricate interrelations of these quantities in a heuristic manner are seen.

Let us assume that we have decided to use E_a as shown in Figure 9. Thus, we now have the 3 boundary lines with E_1, E_2, E_3, E_4 and E_a points

A Graphical Approach

on the diagram. Since E_h is in a symmetric position to E_a relative to E_A , this is the next point on the diagram. Afterwards, we can interconnect point O with E_1 , E_2 and E_3 . Then we can draw a parallel to $\overline{OE_3}$ through E_a which intersects $\overline{OE_1}$ at point P_4 . Since the point at which the parallel line $\overline{OE_2}$ will intersect $\overline{P_4E_a}$ and $\overline{OE_1}$ is as yet unknown, the longest one through E_a which intersects $\overline{OE_1}$ at P_1 is selected tentatively. A vertical line dropped to the base from P_1 gives P_2 . If E_h on the left is interconnected with point 1 at the right corner and extended until it intersects the E_2 level, we obtain point P_3 . According to the basic patterns demonstrated in Figure 7, one of the major construction lines has to go through points P_2 and P_3 . The other extreme occurs when the parallel to $\overline{OE_2}$ shrinks into point P_4 , the base projection of which is P_5 . According to the basic pattern, the line defining the boundary point between g_1 and g_2 goes through P_5 and P (the intersection point of $\overline{E_h1}$ with the E_3 level). Point P_6 is obtained where the extensions of $\overline{P_2P_3}$ and $\overline{P_5P}$ intersect each other. All lines go through P_6 which cut out the left end of the g_2 interval from the base line as the parallel lines to $\overline{OE_2}$ are changed. In the solution, this line has to go through point E_1 too, thus the P_7 solution is obtained at the intersection point of P_6 with E_1 ; $g_1 = \overline{OP_7}$. The intersection of $\overline{P_7E_1}$ with the E_2 level yields point P_{11} . P_{10} , the right end point of the g_2 interval, is obtained where the extension of $\overline{P_{11}P}$ intersects the base. Thus, $g_2 = \overline{P_7P_{10}}$ and $g_3 = \overline{P_{10}1}$. We could have obtained g_2 by intersecting $\overline{OE_1}$ at point P_8 with the vertical line drawn from the base at P_7 . The parallel to $\overline{OE_2}$ from P_8 intersects $\overline{P_4E_a}$ at P_3 . The vertical line drawn from P_8 has to intersect the base at the obtained P_{10} point, thus, the second approach can be used as a check on the accuracy of the previous construction.

The solution to a four phase problem can be seen in Figure 10. In this case, in addition to the given E_1 , E_2 , E_3 , E_4 and E_a values two additional parameters can be freely chosen within the allowable limits. Choosing E_a and $g_1 = \overline{OP_1}$ with values that can be seen in Figure 10, point O is interconnected with E_1 , E_2 , E_3 , E_4 and point E_1 with P_1 after all these points are put on the three sides of the framework. Next, a vertical line is dropped to the base at P_1 which intersects $\overline{OE_1}$ at P_2 . The parallel to $\overline{OE_2}$ from P_2 intersects the parallel to $\overline{OE_4}$ from E_a at P_3 . As in the previous case, the exact intersection points of the parallel to $\overline{OE_3}$ with $\overline{P_2P_3}$ and $\overline{P_3E_a}$ are unknown, therefore, the two extreme cases between which the actual solution occurs are chosen.

The parallel through E_a intersects $\overline{P_2P_3}$ at P_4 ; the projection of P_4 at the base is P_5 . The P_6 point where the $\overline{E_h1}$ line intersects the E_3 level has to go through the line from P_5 which goes through the left end of the g_3 interval under the given assumption. When the parallel interval shrinks into point P_3 , the g_3 interval shrinks into the P_7 point which means that the line crossing the base at the left end is the same as the line crossing the base at the right end and, therefore, it has to go through point P where $\overline{E_h1}$ intersected the E_4 level. P_8 is at the intersection of the extensions of $\overline{P_5P_6}$ and $\overline{P_7P}$. This is the common intersection point of all those lines which intersect the base at the left end of the g_3 interval as the parallel lines to $\overline{OE_3}$ are shifted. For the solution, this line has to go through point P_9 (intersection of $\overline{E_1P_1}$ with the E_2 level). Also, the solution is obtained by extending $\overline{P_8P_9}$ until

it intersects the base at P_{10} . Thus, $g_2 = P_1P_{10}$. P_{11} is at the intersection of $\overline{P_9P_{10}}$ with the E_3 level. The extension of $\overline{P_{11}P}$ intersects the base at P_{12} which is the right end of the g_3 interval, i.e., $g_3 = P_{10}P_{12}$, $g_4 = P_{12}P$. Thus, the solution with the assigned E_a , g_1 values is obtained. As in the previous case, the other alternative from P_{10} through P_{13} , P_{14} to P_{12} could have been chosen.

The basic patterns for solution of the 3-phase and 4-phase cases can be seen in Figures 9 and 10. Obviously, the same pattern can be repeated irrespective of the value of n . Where E_a is chosen as one of the free parameters, the first $(n-3)$ g parameters also can be chosen freely. The point where the line parallel to $\overline{OE_n}$ through E_a has its intersection with the line with the slope of E_{n-2} above the $\overline{O, I}$ is sought; this point is to the right of point P (the intersection point of $\overline{E_{n-1}}$ with the E_n level). Due to the very picturesque diagrams, this can be seen intuitively by the designer who can see within what approximate limits he can vary his parameters. Changes in these diagrams as n increases are the level on which that line segment starts which will define the dividing end points between g_{n-2} and g_{n-1} segments on the base. For $n-3$, it began at point E_1 ; for $n-4$, this starting point will be on level E_{n-2} from the point on level E_2 and any general n case. A second point for this line always can be defined with the method of the two extreme positions of the parallel to the $\overline{OE_{n-1}}$ line segment.

In the two examples, we assumed "composite hard" models. If a "composite soft" model were assumed, the problem would be equally simple. As seen in Figure 7, if E_H is given an E_a value (assuming that $n \geq 3$) also can be freely chosen. The R intersection point of $\overline{E_{H1}}$ with $\overline{E_a 0.5}$ gives the level of E_h . By dividing $E_a E_h$, we obtain an "equivalent" E_A from where the problem is the same as before.

Solution with the Aid of a Computer Graphics Terminal

The first technique can be adopted easily to the graphics terminal of a computer. Since all lines are straight, it can be handled entirely with a light pen. On the other hand, programs can be developed where only the $E_1, E_2, \dots, E_n, E_A, E_a, g_1, g_2 \dots g_{n-3}$ are typed and a diagram appears on the screen. On the basis of the graphical message of this diagram, the designer can type the updated values of $E_a, g_1, g_2, \dots, g_{n-3}$. In this conversational mode, the operator can not only find a solution but can find a whole set of solutions from which he can choose the optimum one.

The laminar model also is adaptable to analog computers where only summing amplifiers are used while the g blending ratios will be set on potentiometers. Instead of manually changing the potentiometer settings in a true hybrid operation they can be automatically changed until solution (or optimal solution) is reached.

ACKNOWLEDGMENT

This work was sponsored by NASA Grant NGR 01-005-004.

A Graphical Approach

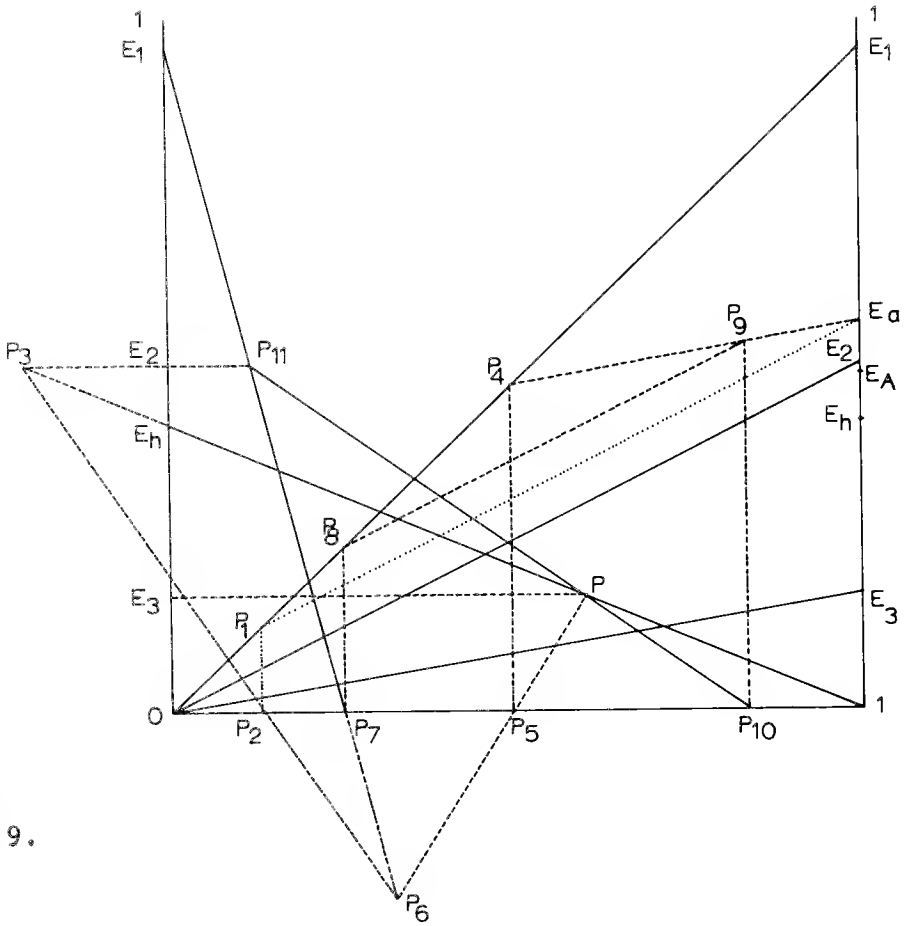


FIGURE 9.

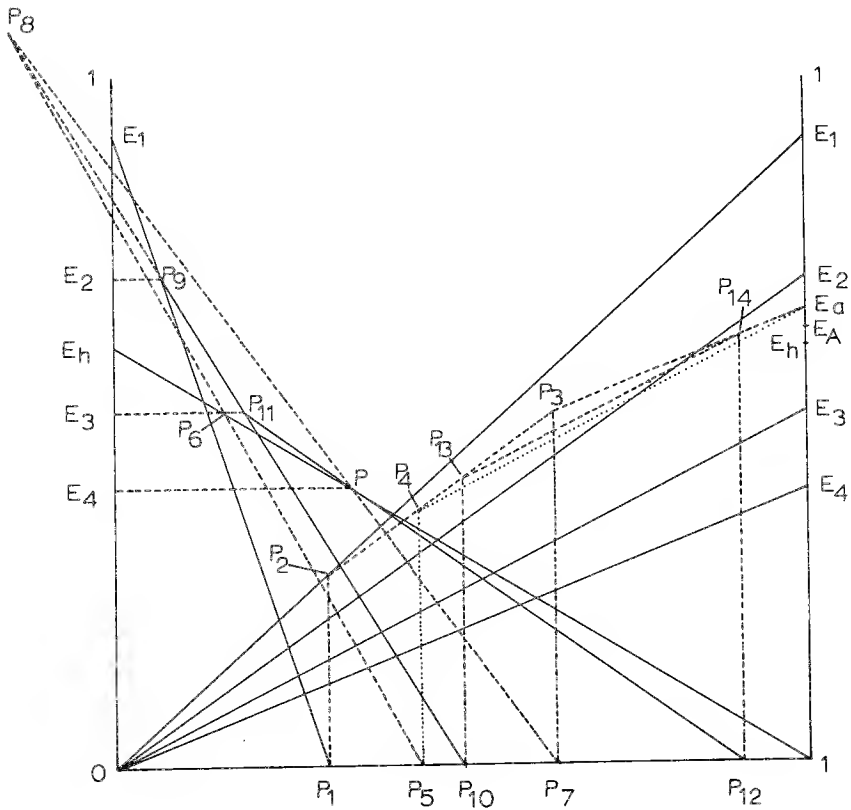


FIGURE 10.

LITERATURE CITED

1. Erdey, M. R. A. 1963. Rectangular diagrams and their applications to network theorems. Proc. Sixth Midwest Symposium on Circuit-Theory: F-1 - F-17. Madison, Wisconsin.
2. _____. 1968. The misrepresented duality and the rectangular diagrams. Proc. IEEE Region III Convention: 9.5.1 - 9.5.10. New Orleans, Louisiana.
3. _____. 1968. Rectangular diagrams in graph theory. Proc. Eleventh Midwest Symposium on Circuit Theory: 441-456, Notre Dame, Indiana.
4. Hansen, J. C. 1965. Theories of multi-phase materials applied to concrete, cement mortar and cement paste. Proc. Intern. Conf. on Structure of Concrete. London, England.
5. Paul, B. 1960. Prediction of elastic constants of multi-phase materials. Trans. Metallurg. Soc. of ASME 218:36-41.
6. Popovics, S. 1969. The model approach to two-phase composite solids. J. Amer. Ceramic Soc. Bull. 48:1060-1064.
7. Popovics, S., and Erdey, M. R. A. 1970. Estimation of the modulus of elasticity of concrete - like composite materials. Materials and Structures - Testing and Research 3 (16):253-260.

Rectangular Diagram Approach

RECTANGULAR DIAGRAM APPROACH TO DETERMINE THE ELASTIC DEFORMATIONS OF NON-LINEAR N-PHASE COMPOSITE SOLIDS

Michael R. A. Erdey
Electrical Engineering Department
Tuskegee Institute, Alabama

INTRODUCTION

Rectangular diagrams have been used for the solution of linear (1, 2, 4) and non-linear (3) electrical networks. In the case of non-linear problems, analytical expressions are becoming more and more unmanageable as the complexity of the problem increases. On the other hand, rectangular diagrams can be easily handled even in the more complex cases. An additional advantage of rectangular diagrams is that they are easily adaptable to the graphics terminal of a computer, such as the NASA developed AMTRAN-terminal.

Laminar Models and Their Electrical Network and Rectangular Diagram Representation in the Linear Case

The laminar model and its electrical equivalent were fully discussed in the previous paper (5).

The basis for the electrical equivalent network is the analogy between Hooke's and Ohm's laws as can be seen from equations:

$$\sigma = \epsilon E \quad (1)$$

$$v = i R \quad (2)$$

where, σ = stress, ϵ = strain, E = modulus of elasticity, v = voltage, i = current, and R = resistance.

The v - i characteristic curve of the linear resistor of equation (2) or the σ - ϵ characteristic curve of a linearly elastic material is represented by a straight line, like that in Figure 1-a. The slope of the characteristic curve is equal or proportional, if the unit lengths for v and i are chosen differently, to the resistance in the electrical model and to the Young modulus in the elastic model.

If we drop from the P operational point of Figure 1-a perpendicular to the two axis, we obtain a rectangle, Figure 1-b.

In case of non-linear elastic materials and non-linear resistors the analog equations (1) and (2) go into the analog equation pair of (3) and (4).

$$\sigma = f(\epsilon) \quad (3)$$

$$v = f(i) \quad (4)$$

Here, the v - i or σ - ϵ characteristic curves will no longer be straight lines. An example of a non-linear v - i characteristic curve

can be seen in Figure 2-a. From the P operational point, a rectangle can be completed again which is redrawn in Figure 2-b.

The value of completing the rectangles from the operational points clearly can be seen from the example given in Figure 3. In Figure 3-a, a non-linear resistive network is given and its solution in rectangular diagram form is given in Figure 3-b.

The horizontal sides of the component rectangles are equal (proportional) to the current through the pertinent resistive element. The vertical sides are equal (proportional) to the voltage across it and the area is equal (proportional) to the power consumed by the element. In linear case, the slope of the diagonal of the rectangle would be equal to the element value of the linear resistor. Along horizontal lines, Kirchhoff's node laws are satisfied, while along the vertical lines the Kirchhoff's voltage laws are satisfied. The resultant rectangle is the power rectangle of the driver. This rectangle is contiguously filled with the component rectangles, which expresses conservation of energy in graphical form. The solution techniques in rectangular diagram form are given elsewhere (1,2,3,4) for both the linear and the non-linear cases.

Rectangular diagrams follow the pattern of the network diagram (4). Since the laminar models can be represented with series-parallel resistive network analogs, the rectangular diagrams will also be placed in a series-parallel contiguous fashion to each other.

The Non-Linear Problem

The basic equations for the linear case, with the aid of the laminated model (5), were:

$$E_a = g_1 E_1 + g_2 E_2 + \dots + g_n E_n \quad (5)$$

$$\frac{1}{E_a} = \frac{g_1}{E_1} + \frac{g_2}{E_2} + \dots + \frac{g_n}{E_n} \quad (6)$$

$$E_A = \frac{E_a + E_b}{2} h \quad (7)$$

$$\frac{2}{E_H} = \frac{1}{E_a} + \frac{1}{E_h} \quad (8)$$

$$g_1 + g_2 + \dots + g_n = 1 \quad (9)$$

Note that equation (5) can be represented with series connected resistors while equation (6) can be represented with parallel connected resistors. Equation (8) combines (5) and (6) series while equation (9) represents the parallel interconnections of (5) and (6).

The non-linear equivalents of equations (5) to (8) are given in equations (10) to (13).

$$f_a(\epsilon) = g_1 f_1(\epsilon) + g_2 f_2(\epsilon) + \dots + g_n f_n(\epsilon) \quad (10)$$

$$f_h^{-1}(\sigma) = g_1 f_1^{-1}(\sigma) + g_2 f_2^{-1}(\sigma) + \dots + g_n f_n^{-1}(\sigma) \quad (11)$$

$$f_A(\epsilon) = \frac{f_a(\epsilon) + f_h(\epsilon)}{2} \quad (12)$$

$$\frac{2}{f_H(\epsilon)} = \frac{1}{f_a(\epsilon)} + \frac{1}{f_h(\epsilon)} \quad (13)$$

Since the σ - ϵ curves are defined only for positive values, the characteristic curves are defined only in the first quadrant of the coordinate system. If we change the negative ϵ and σ axis into a positive one, as in Figure 4, we can repeat the same function in all four quadrants. Since we are representing the same function in all four quadrants, with I to IV subscript, we can express which quadrant is the characteristic curve constructed as can be seen on the subscripted f in Figure 4. If the function already has a subscript, then the subscript is followed by a comma and then by the quadrant subscript. If only the first quadrant characteristic curves will be used, as in Figures 6 and 7, the quadrant subscript will not be used. The usefulness of this notation will be apparent from the application in Figure 5.

To understand Figure 5, the reader should note that $f(\epsilon)$ and $f^{-1}(\sigma)$ are the same functions; only the vantage points from which they are looked at are changed. The first is looked at from the ϵ axis, the second from the σ axis. Therefore, a multiplication by a $g < 1$ factor will shrink the $f(\epsilon)$ function with the g proportion toward the ϵ axis and the $f^{-1}(\sigma)$ function will shrink in g proportion toward the σ axis.

A non-linear 2-phase composite material is depicted in Figure 5. Accordingly to equation (10), $\sigma_a = f_a(\epsilon)$, we have to multiply $f_1(\epsilon)$ by g_1 and $f_e(\epsilon)$ by g_2 . This has been done for $g_1 = \frac{2}{3}$ and $g_2 = \frac{1}{3}$. Having f_1 in the first quadrant and f_2 in the fourth one, the vertical distance between the $\frac{2}{3} f_{1,I}(\epsilon)$ and $\frac{1}{3} f_{2,IV}(\epsilon)$ curves will give to every ϵ the related value. In a similar fashion by using the $\frac{2}{3} f_{1,I}^{-1}(\sigma)$ and $\frac{1}{3} f_{2,II}^{-1}(\sigma)$ diagrams the $\epsilon_h = f_h^{-1}(\sigma)$ is given by the pertinent horizontal distance between the two characteristic curves for each allowable value of σ .

Combination of equations (10) and (11) into equations (12) and (13) is very difficult to see in the form of Figure 5, but can be easily accommodated in the rectangular diagram form of Figures 6 and 7. In these figures, all first quadrant characteristic curves were included and, therefore, there was no need for double subscripts. Secondly, there was no need to include the notations for the functions and their inverse since the parallel connected single rectangles are related to the inverse function. Therefore, instead of the f symbols, we put the pertinent g blending ratios beside the characteristic curves. For convenience in construction, the two factors of equations (12) and (13) were omitted. Thus, in Figure 6, the actual $\sigma_A = f_A(\epsilon)$ is half of the height of the figure while in Figure 7, the actual $\sigma_H = f_H(\epsilon)$ is double the given height of the diagram.

Both diagrams are given for a particular σ - ϵ pair, but can be extremely useful if they are displayed on the graphics terminal of a computer. From these diagrams, the operator can decide in a conversational mode with the computer which parameters to decrease and which to increase in order to obtain the required results. For example, if the problem is to obtain to a given maximum σ in the form of Figure 6 a required ϵ value, assume that the height of Figure 6 is adjusted to the required a value but E has to be smaller. We can see by inspection that this can be done by decreasing g_1 and increasing g_2 . Assume that g_1 is decreased to $\frac{1}{3}$ and g_2 increased to $\frac{2}{3}$ ($g_1 + g_2 = 1$ has to be satisfied).

We can see that the width of the right rectangle of the two parallel ones decreases by half while the width of the left rectangle increases 2 x. Taking into account these relative sizes, this operation has to decrease the overall width. At the same time, from the two series rectangles the height of the bottom one will decrease by half, while the height of the top one will increase 2 x. Observation of relative sizes will give some overall height gain which will be compensated by moving toward the left on the respective characteristic curves at the end, since we have to take into account the decrease in the value of ϵ . Thus, we can be sure at a glance that this operation will result in decreasing ϵ for the same value of .

The general n-phase case for $n > 2$ cases will be equally simple with the aid of the rectangular diagrams. Instead of two rectangles, we will have n rectangles side by side and n rectangles above each other and the two groups will be put in either series to each other or parallel to each other. For example, in the case of four elements, we will have the configurations of Figures 8 and 9. Since g blending ratios will be given along the characteristic curves, the operator will again be in the position to judge which parameters should be changed and by approximately how much by mere inspection of the diagrams. Thus, the rectangular diagrams will serve as good notations to make the right decisions in an interactive situation on a graphics terminal of a computer.

A very crude justification of the laminar model can be the argument that in composite materials the particles of the various phases are dispersed in all directions. That is, they can be found in parallel and also in series. Therefore, a combination of series-parallel lamination will be nearer to the truth. The "composite hard" sub-cases also make sense since a continuous phase should have more effect on the overall behavior of the material. Therefore, if the elastic modulus of the continuous phase is one of the largest (smallest) values, we have a "composite hard" (soft) case since the arithmetic (harmonic) mean is always larger (smaller) than the harmonic (arithmetic) mean. But the physical justification of the laminated model is given by the large amount of experimental data which give a nice correlation between the measured data and the calculated values from the laminated model. In the case of non-linear materials, this type of correlation is not yet available. The meaning of "composite soft" and "composite hard" material is also not clear in the non-linear domain. The σ - ϵ characteristic curves can be such that in a certain operational region the very same material can be looked upon as a composite soft material relative to the other ones while in another operational region it might behave as a "composite hard" material.

Rectangular Diagram Approach

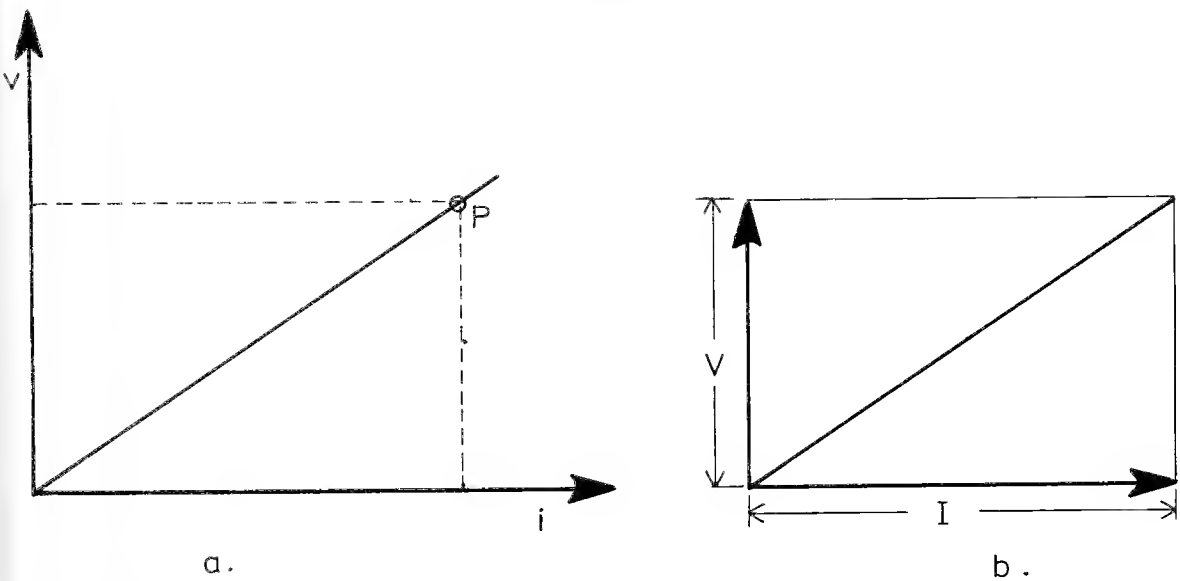


FIGURE 1.

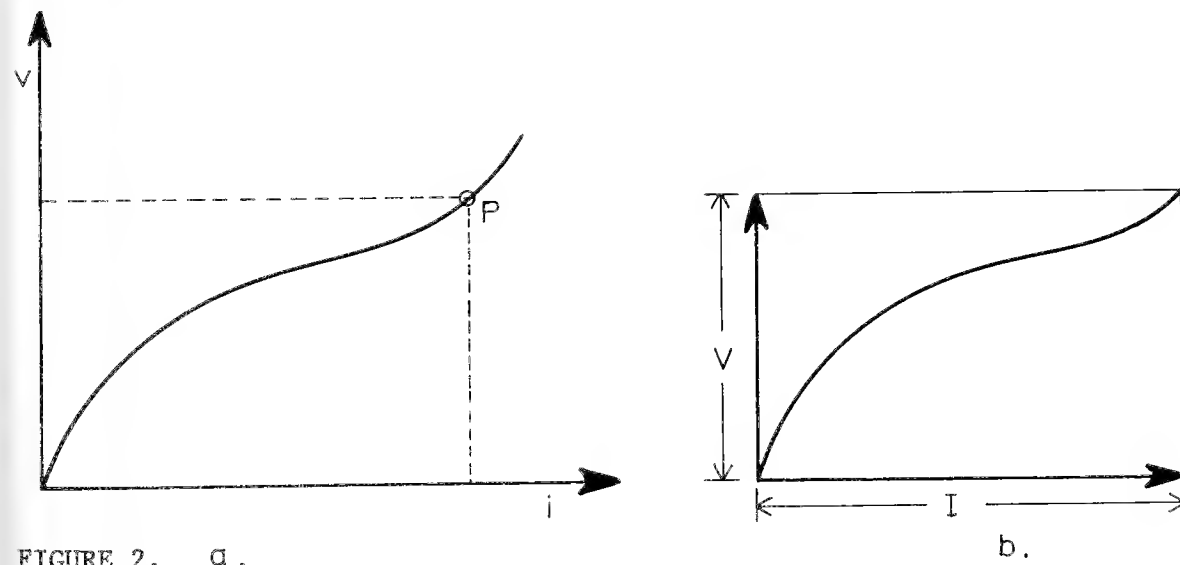


FIGURE 2. a.

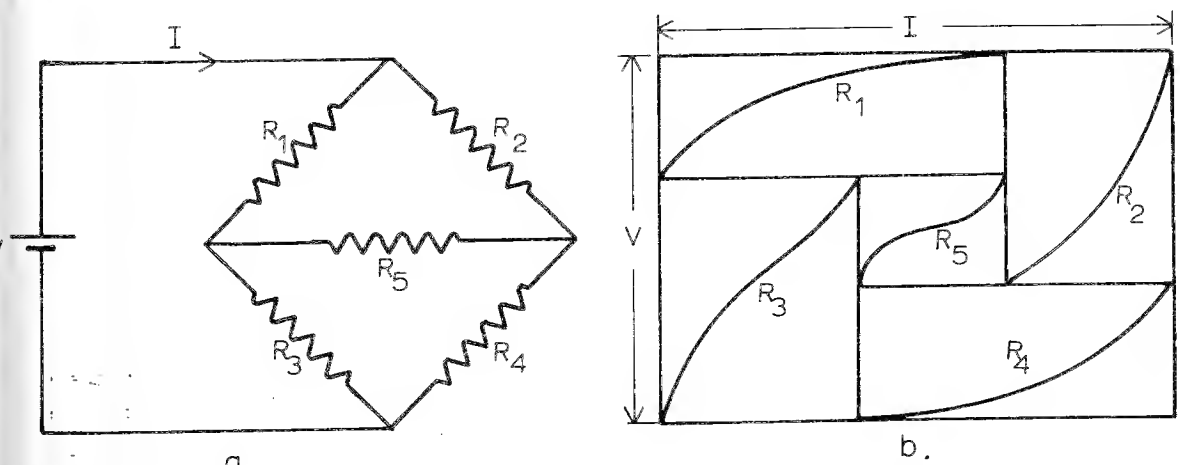


FIGURE 3.

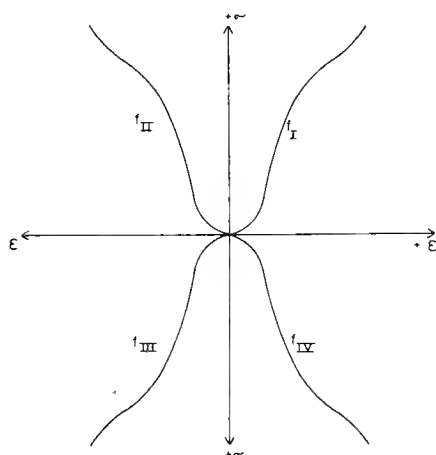


FIGURE 4.

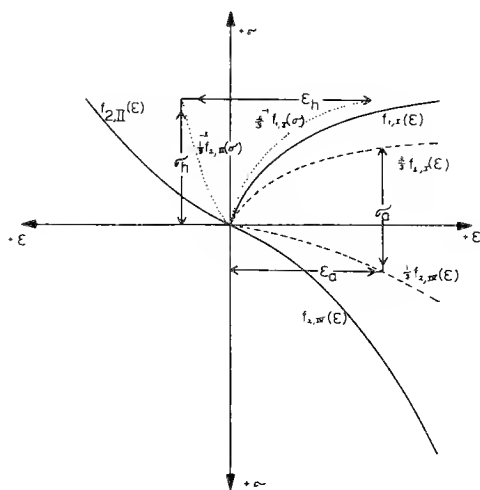


FIGURE 5.

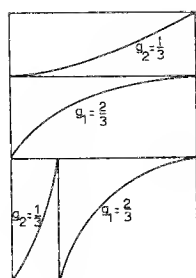


FIGURE 6.

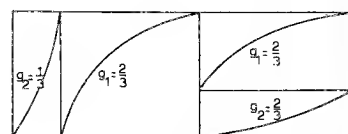


FIGURE 7.

Rectangular Diagram Approach

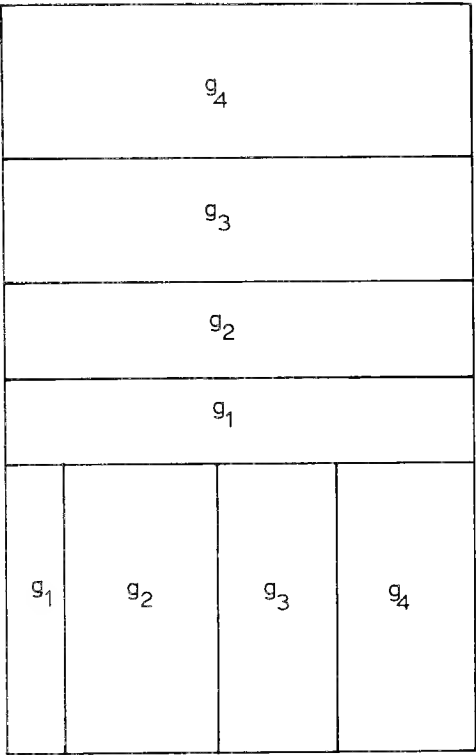


FIGURE 8.

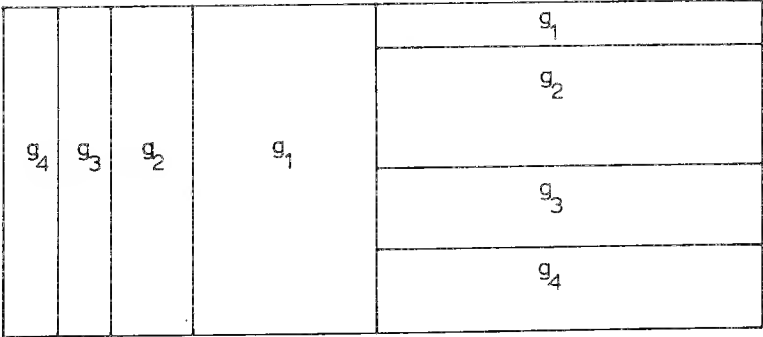


FIGURE 9.

ACKNOWLEDGMENT

This work was sponsored by NASA Grant NGR 01-005-004.

LITERATURE CITED

1. Erdey, M. R. A. 1963. Rectangular diagrams and their applications to network theorems. Proc. Sixth Midwest Symposium on Circuit Theory: F-1 - F-17. Madison, Wisconsin.
2. _____. 1968. The misrepresented duality and the rectangular diagrams. Proc. IEEE Region III Convention: 9.5.1 - 9.5.10. New Orleans, Louisiana.
3. _____. 1968. Iterative solution of non-linear resistive networks with the aid of the rectangular diagrams. Proc. Eleventh Midwest Symposium on Circuit Theory:371-388. Notre Dame, Indiana.
4. _____. 1968. Rectangular diagrams in graph theory. Proc. Eleventh Midwest Symposium on Circuit Theory:441-456. Notre Dame, Indiana.
5. _____. 1971. A graphical approach to determine the elastic deformations of linear n-phase composite solids. J. Ala. Acad. Sci. 42:81-93.
6. Hansen, T. C. 1965. Theories of multi-phase materials applied to concrete, cement mortar and cement paste. Proc. Intern. Conf. on Structure of Concrete. London
7. Paul, B. 1960. Prediction of elastic constants of multi-phase materials. Trans. Metallurg. Soc. AIME 218:36-41.
8. Popovics, S. 1969. The model approach to two-phase composite solids. J. Amer. Ceramic Soc. Bull. 48:1060-1064.

Strippable Coal Reserves of Alabama

SOME PROBLEMS OF ESTIMATING STRIPPABLE COAL RESERVES OF ALABAMA

Reynold Q. Shotts
University of Alabama
University, Alabama

This estimate of strippable bituminous coal reserves for the state of Alabama is part of a nation-wide project by the U. S. Bureau of Mines. When completed, it will be subjected to correction for strip coal production and thus made a continuing inventory of strippable bituminous coal reserves. The estimate was made largely from the published literature since no provision was made for field work or collection of company maps, etc.

PRODUCTION

Figure 1 shows total recorded production of Alabama coal (1). A small quantity was produced prior to and during the Civil War from the small Cahaba and Coosa coalfields and no doubt some small part of later production has been missed. However, it is doubtful if the absolute total exceeds the sum shown in Figure 1 by more than a few hundred thousand to a million tons. Figure 2 shows the history of surface-mined coal production (2,3). The percent of total production that was mined by surface methods each year is also given.

In Figure 1, the average annual coal production for each 5-year interval, 1870-74 to 1965-69, is shown. In 1939, the State Mine Inspectors report was only for the first nine months of the year when the statistics were changed to the State fiscal year basis, Oct. 1 to Sept. 30. The 1935-9 period, therefore, really was only 4 3/4 years long. The 1965-69 period covered only 4 reporting periods. Effects of the 1930's depression and of the "recessions" of the 1950's, coupled with the loss of domestic and locomotive markets before the "boom" in utility fuel, are evident. Both "depression" periods also show up in coke production. The latter curve is especially interesting in that a steady trend showing an increase of about 74,300 tons per year appears to have dominated the first 74 years of coke production.

The 1965-69 production suggests a recovery sufficient for "leveling off" or even for continued rise. Undoubtedly, steel production increased more rapidly because, in that period coke was used for domestic and other non-steel making purposes and steel-making technology has steadily decreased the pounds of coke required to produce a ton of steel.

Figure 2 reveals a longer history of surface mining for Alabama than is generally suspected. As mentioned in 1915: "A few tons listed under 'other methods of mining' were produced by steam shovel mining." In 1916, a figure of 75,462 tons was given for "steam shovel" production(29). During the WW I period about 2% of the total state tonnage was stripped and this proportion continued through the 1920's. In the 1930's, surface mining fell off more proportionally than did underground mining and in 1937 and 1938, was only 0.3% of the total. After 1940, strip production rose rapidly until the end of WW II but not much more rapidly than did

underground mining. The increase in strip production was slow but steady from 1944 to 1963. Total production remained rather static and the percent of strip-mined coal increased rapidly during that period. Since 1964, the strip-mined proportion has almost sky-rocketed with only a modest rise in total production. This has resulted in a 1960 decade rise in percent of coal-mine by stripping from 20.3 to 43.7%. If this trend is to continue, the question of the size and availability of strippable coal reserves is very timely for the 1970's.

Strippable coal reserves are fairly easy to estimate given adequate maps and outcrop data. However, these are rarely available on a regional basis although in Alabama the map situation has greatly improved in recent years. Other factors are much more difficult to evaluate. The most important of these are the progress of mining technology and trends in mining costs and coal prices. Others are: (1) Availability of coal reserves for mining. The strippable coal deposits within the city limits of Birmingham and surrounding municipalities are not likely to be mined. Coal under valuable farming land, unsettled estates, young growing timber stands, interstate highway and railroad rights-of-way, airports and water reservoirs is not likely to be available for mining or extraction must be deferred for long periods. (2) Unavailability of large, contiguous blocks of coal land. Modern stripping with heavy equipment simply cannot compete if the work must be moved frequently to small, isolated blocks of coal. Such deposits can be mined by smaller equipment but this is more expensive and high wells must be lower with resulting lesser surface extraction. First stripping with small equipment which can get only the "cream" may often withdraw as large a reserve for practical future stripping as it produces.

TOPOGRAPHIC MAPS

Figure 3 shows the extent of coverage of the coal-bearing areas of Alabama by topographic maps. County lines, the approximate boundaries of the coal fields and the total area covered by the strippable coal reserve study are also sketched in.

All the areas underlain by Pennsylvanian Age rocks were not covered. The only topographic quadrangles included in Figure 3 were those in which at least one small area has coal deposits mentioned in some detail in the literature or which the author has seen. The Cahaba and Coosa coal-fields are fully covered but there must be 20-30 1:24,000 quadrangle areas (a few unmapped) in the Warrior and Plateau coalfields, underlain, partially or wholly by Pennsylvanian Age rocks, that were not included. Principally, they are several quadrangles in eastern Madison and western Jackson counties; probably all quadrangles in Marshall; some in western Dekalb and Cherokee; northern Etowah, Jefferson, Cullman and Winston; southern Morgan, Lawrence and Franklin and western Marion counties. Western Fayette; all of Lamar and Pickens; practically all of Tuscaloosa and parts of southwestern Bibb and northern Hale, Green and Sumter counties, probably are underlain at depth by Pennsylvanian rocks.

The only unmapped area included in the strippable reserve estimate was the tier of quadrangles extending across southern Winston and Cullman counties and designated A-F in Figure 3. Names shown in Table 1 are of a

Strippable Coal Reserves of Alabama

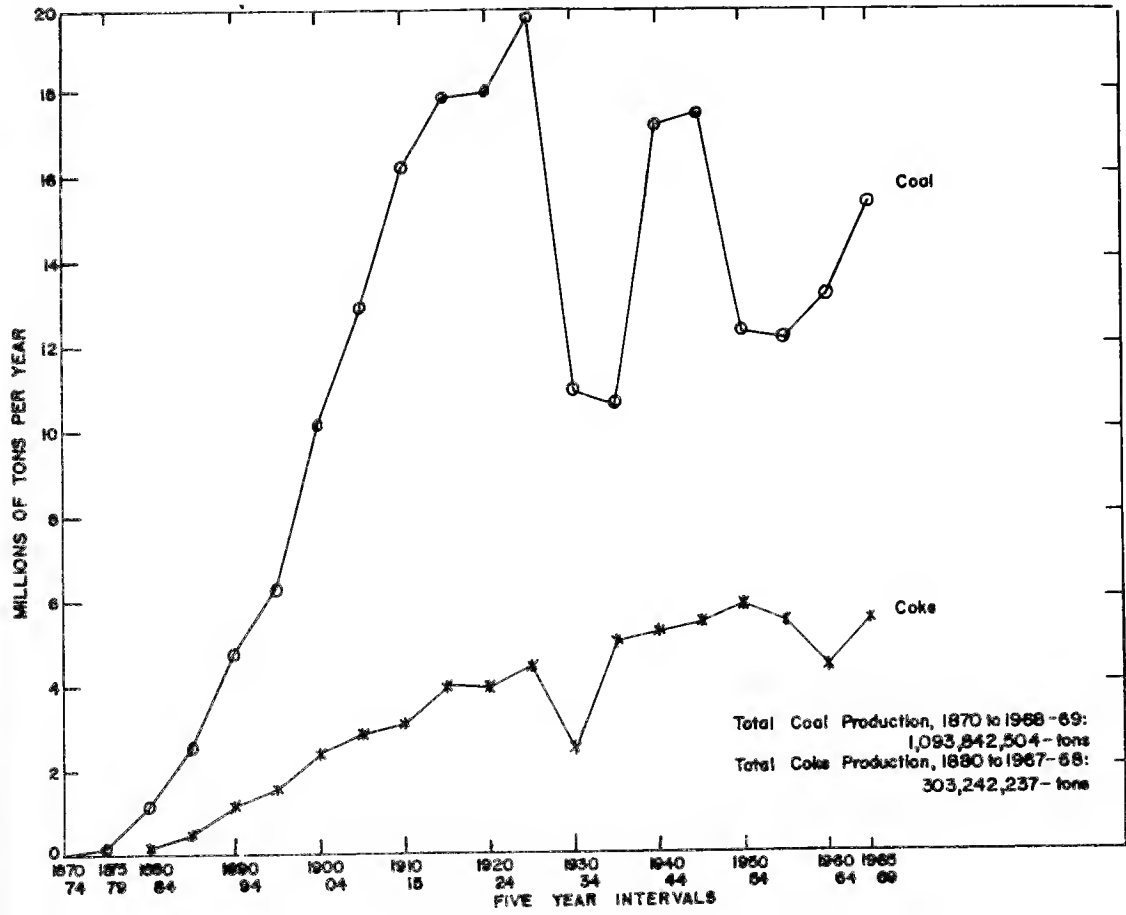


FIGURE 1. Average annual (average of each 5 year period) coal and coke production in Alabama, tons.

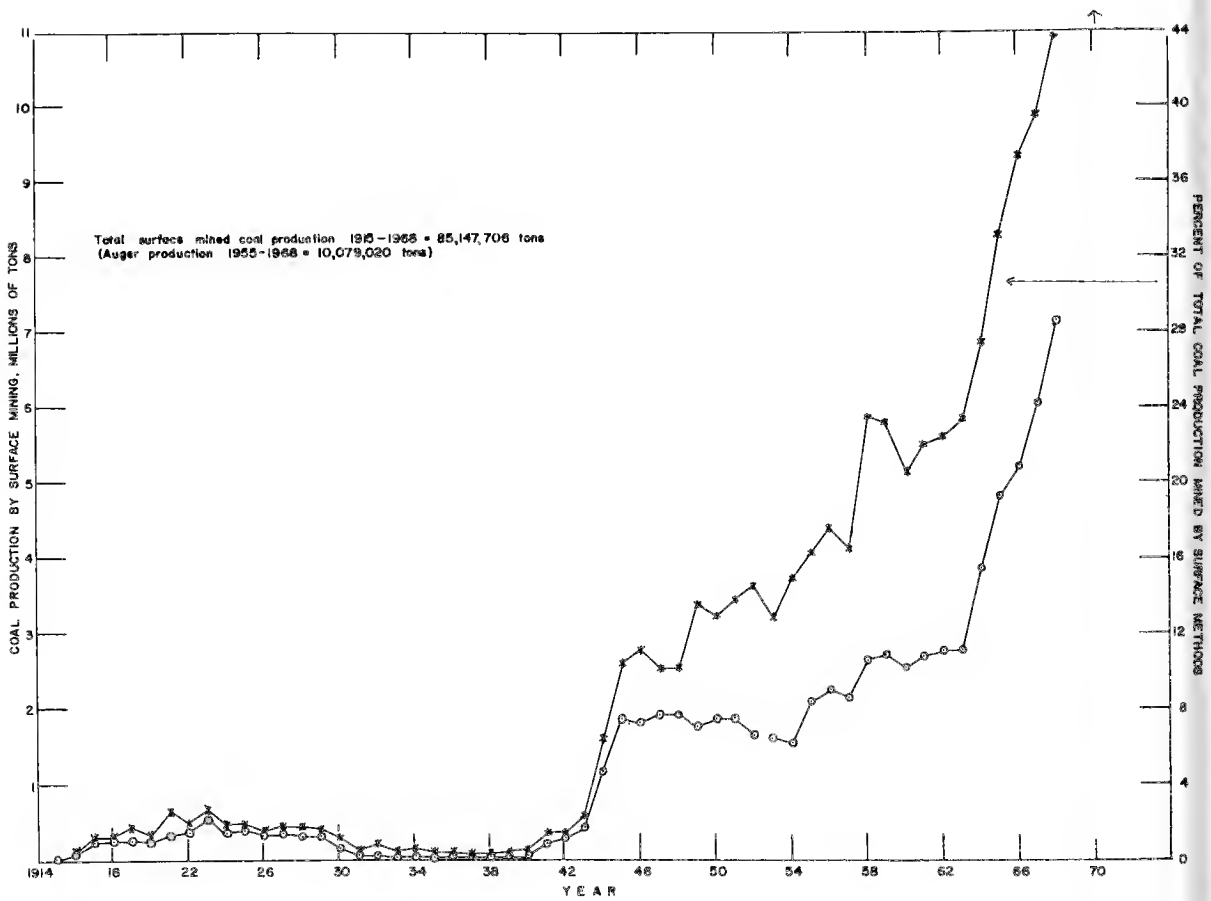


FIGURE 2. Total surface mined coal production and percent of total production mined by surface (strip and auger) methods, state of Alabama.

Strippable Coal Reserves of Alabama

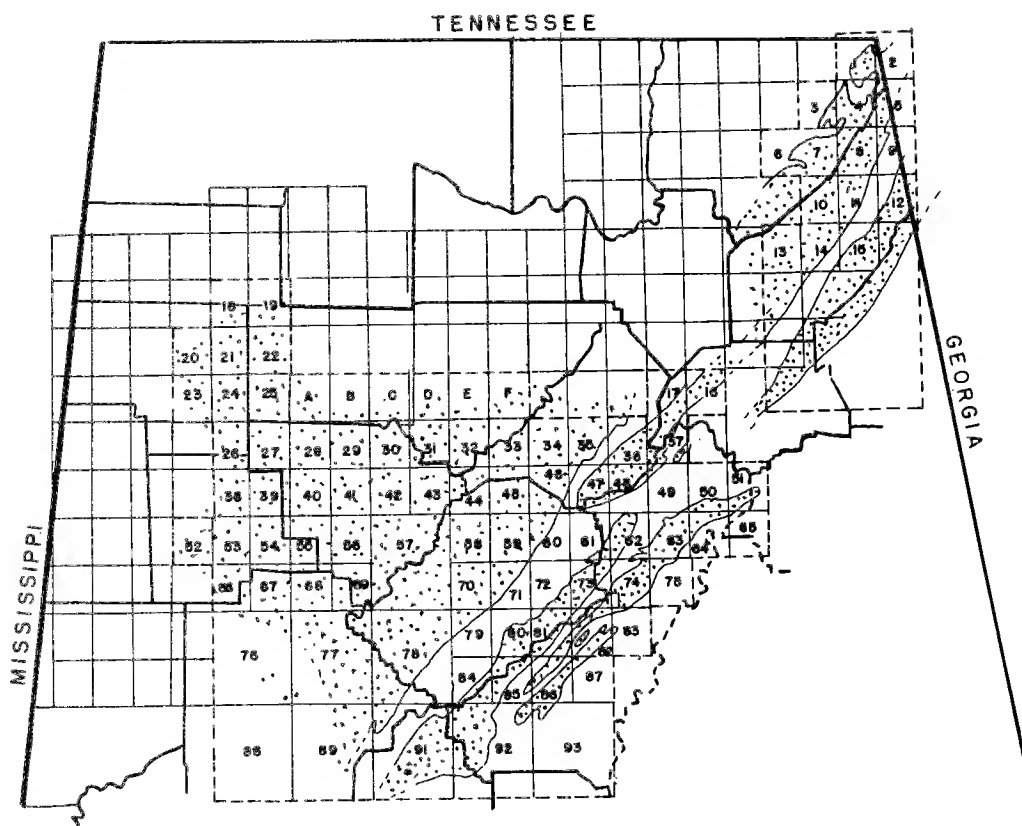


FIGURE 3. Index map of topographic quadrangles covered in strippable coal reserve study.

community located in each and are "unofficial". They were included in order to complete the outcrops of the Jefferson and Black Creek beds. That outcrop is shown on McCalley's (19) map of the Warrior coalfield. An Army Map Service map of the Gadsden quadrangle (1:250,000), having 50 and 100 ft contour intervals, was "blown up" and the areas shown by McCalley as underlain by the Black Creek group of coalbeds were roughly "fitted" to the topography. This resulted in planimetric maps of a low order of accuracy with respect to length of outcrop and to area underlain by the beds, but this was considered to be better than nothing.

Table 1 shows a great variation in age and scale of the topographic maps available. The 1898 Fort Payne map has only 50-ft contours and township, range and section lines are missing. Five of the 16 7-1/2 minute quadrangles into which it may be divided have been remapped on the 1:24,000 scale. Fortunately, these maps include most of Sand Mountain but very little of Lookout. All 1:62,500 maps have 20-ft contours and do have T, R, and S, lines on them but rugged terrain in the Blocton, Port Birmingham, Searles and Yolande quadrangles results in badly crowded contours in places.

The obsolete culture and place names shown on maps older than 1945 sometime lead to difficulties in locating oneself in the field. The Blocton map, for example, shows double or 3 times the railroad mileage now active within the county.

Before the advent of TVA, especially in the 'teens and 1920's when State coal production was a maximum, good topographic maps were acutely scarce. Note that only the Columbiana and Montevallo quadrangles of the 1:62,500 scale, antedate 1924 although Bessemer, Vandiver, Leeds and Birmingham Coal District, all since divided and mapped on 1:24,000 scale, were just older than these. The newest map on this scale is Port Birmingham (1935). The earliest 1:24,000 map is dated 1947!

Considering the late start, modern mapping has proceeded fairly rapidly. The recent coverage of Marion, Lamar, Fayette and part of Pickens counties is a great help. When the Winston-Cullman-Blount and Cherokee-Dekalb-Etowah gaps are plugged, Alabama Pennsylvanian geology can be mapped on an adequate base.

GEOLOGIC MAPS

The situation with regard to geologic mapping was long better than for topographic mapping but is now much further behind.

The oldest map published by the State is that of the Cahaba coalfield by Joseph Squire (27). In the Plateau Coalfield, geologic maps were included in USGS Folios, by Hayes of the Stevenson (15) and Gadsden (16) quadrangles. Squires' map is planimetric, on a scale of about 1:48,000, in color and shows some coalbed outcrops. The maps of Hayes are also in color, on a scale of 1:125,000 and show locations of some coal deposits but show no coalbed outcrops. Hayes' maps are of very little value in coal resource studies and Squires' maps have been replaced by smaller scale, uncolored but more complete ones. These are those of Butts in his report on the northern part of Cahaba Coalfield (7) and on the southern part (9). They are on scales of about 1:115,000, planimetric, have coalbed outcrop lines and show some localities and coalbed thicknesses. Maps of parts of both the Cahaba and Coosa Coalfields are covered in color and on a scale of 1:62,500, in Butts' USGS Folios 175 (8), 221 (10), and 226 (11). Folio 175 covers more of the Warrior than of the Cahaba coalfield.

Fortunately, the Warrior coalfield has long been mapped. McCalley's (19) map is on a scale of about 1:125,000, planimetric, in color and not only carries coalbed outcrop lines but many bed outcrop localities and thicknesses. If the information on this map could be perfectly fitted to modern topographic maps, it would fulfill most of our needs.

The only substantial part of the Warrior coalfield in which geology is mapped on topography is the Birmingham quadrangle of Butts (8). A small corner of the Warrior coalfield is covered by the Bessemer-Vandiver Folio (10).

A map of the complete Coosa coalfield, in color, by W. F. Prouty (20), is planimetric, on a scale of about 1:56,000 and shows bed outcrops and structure sections. Jones (17) published an uncolored, planimetric map (scale about 1:72,000) of the Wattsville Basin part of the field. The planimetric, uncolored maps in Rothrock's (21) report (scale 1:39,000 and larger) covered the same area and along with structural information,

Strippable Coal Reserves of Alabama

TABLE 1. List of quadrangle maps used in estimate.

1. Bridgeport 1945	2. Shellmound 1945	3. Stevenson 1947
4. Flat Rock 1946	5. Trenton 1946	6. Hollywood 1950
7. Henegar 1947	8. Ider 1946	9. Sulfur Springs 1946
10. Sylvania 1947	11. Dugout Valley 1946	12. Valley Hand 1946
13. Chaves 1946	14. Fort Payne 1946	15. Fort Payne (1:125,000) 1898
16. Howellton 1959	17. Altoona 1958	18. Philcampbell 1946
19. Kinlook Springs 1947	20. Brilliant 1967	21. Haleyville West 1958
22. Haleyville East 1958	23. Winfield 1967	24. Gold Mine 1958
25. Lynn 1958	26. Glen Allen 1967	27. Carbon Hill 1967
28. Nauvoo 1949	29. Manchester 1949	30. Sunlight 1949
31. Cold Springs 1944	32. Arkadelphia 1951	33. Blount Spring 1951
34. Nectar 1961	35. Cleveland 1958	36. Oneonta 1958
37. Hyatt Gap 1958	38. Hubbertville 1967	39. Howard 1967
40. Townley 1949	41. Jasper 1949	42. Cardova 1949
43. Sipsey 1949	44. Creel 1951	45. Warrior 1951
46. Trafford 1961	47. Remlap 1960	48. Springville 1958
49. Ashville 1958	50. Cox Gap 1947	51. Ohatchee 1947
52. Fayette 1967	53. Bankston 1967	54. Berry 1967
55. Oakman 1949	56. Parrish 1949	57. Port Birmingham (1:62,500) 1935
58. Brookside 1959	59. Gardendale 1959	60. Pinson 1959
61. Argo 1959	62. Odenville 1958	63. Wattsville 1958
64. Ragland 1947	65. Francis Mill 1947	66. New Lexington 1967
67. Berry S. E. 1967	68. Wiley 1949	69. Tutwiler School 1949
70. Adamsville 1959	71. Birmingham North 1959	72. Irondale 1959
73. Leeds 1959	74. Cooks Springs 1962	75. Pell City 1958
76. Samantha (1:62,500) 1926	77. Searles (1:62,500) 1929	78. Yolande (1:62,500) 1932
79. Bessemer 1959	80. Birmingham South 1959	81. Cahaba Heights 1959
82. Vandiver 1959	83. Vincent 1951	84. Greenwood 1959
85. Helena 1959	86. Chelsea 1959	87. Westover 1959
88. Tuscaloosa (1:62,500) 1924	89. Cottondale (1:62,500) 1931	90. Blocton (1:62,500) 1934 (Rev.)
91. Montevallo (1:62,500) 1908	92. Columbiana (1:62,500) 1909	
A unmapped (Natis)		
B " (Falls City)		
C " (Arley)		
D " (Crane Hill)		
E " (Trimble)		
F " (Hanceville)		

furnished all the information needed for strippable reserve estimates when replotted on 1:24,000 topo maps with 20-ft contours.

Other maps that carry information of limited use, are:

(1) Two maps accompanying a report on Stevenson and Scottsboro quadrangles (4). (2) Small scale maps of areas on Lookout Mtn. (12). (3) A map accompanying report on Blount Mtn. (14). (4) A small outcrop map near Brilliant, Ala. (22). (5) Upper Warrior coalfield maps (23). (6) Revised map of the Southeastern Part of the Cahaba Coalfield (28). (7) Map of part of Marion, Franklin and Winston counties (18). (8) Small scale maps in report on total remaining coal reserves of Alabama (13). These maps serve to limit, roughly, areas of known mineable coal on most coalbeds.

Some other geological maps, including the new Geological Survey of Alabama county series, are fine for general geology but without contours and without coalbed or "marker" bed outcrops, they are of little value in making reserve estimates.

The most copious and useful material from which to construct regional coal reserve estimates are in the files and on the maps of many coal and mineral land companies. Of course some rather large coal-bearing areas are not covered by these maps but they are generally the least promising areas. Since data from company sources are slow in appearing in the literature, most of the coal will be mined before the bulk of the data can be used for coal reserve estimates!

STRUCTURE

Coalbed outcrops are greatly influenced by structural features. Faults initiate as well as terminate coalbed outcrops and the combination of erosion patterns and folds results in greatly lengthening them. Fault traces, fold axes and structure sections are carried on all Butts' maps and on the Coosa field maps. Few other maps emphasize structural features. A small scale map compiled by C. S. Blair (22) shows much of the faulting in the Warrior field. No doubt, most of it was revealed in mining operation.

BED OUTCROPS

In order to estimate strippable coal reserves on a regional basis it is necessary to locate the coalbed outcrops with fair accuracy, to have some definite bed thickness information and to be able to estimate average coalbed dip and topographic slope. Without coalbed outcrops, the other information is rather useless.

A large-scale topographic map carrying coalbed outcrops is the ideal base for strip coal reserve estimates. Only for the small Marion-Franklin-Winston County area is there such a map (18) and it is not generally available! Butts' maps almost reach the ideal but the scale is so small and the outcrop lines necessarily so generalized that they are hard to relate to the topography. Contour intervals in excess of 20 feet make the relation even more tenuous.

Strippable Coal Reserves of Alabama

Of course, often no connection between topography and outcrop is evident at all. If the outcrops are reasonably accurate, even if highly generalized, they may be "fitted" to topography with fair accuracy. If an occasional true outcrop elevation is known, the accuracy is greatly increased. Small drift mine and strip mine symbols fix the bed elevation closely. Recent topographic maps usually show many of these symbols in coal mining areas but older ones usually show only the location of surface structures at the larger mines. The recent, 1967 map of the Carbon Hill quadrangle shows no abandoned strip mines although it is quite certain that some stripping has been done. As attempts were made to fit the complex outcrop pattern of McCalley's (19) map to the topography, it was noticed that some outcrops lay near numerous small ponds.. It suddenly became evident that these ponds were really small strip pits on bed outcrops that were so old and overgrown that the field-check engineers failed to recognize them as such! Thus, it is evident that sometimes if one only has the patience and time scale of the geologist, he realizes that many environmental disturbances will heal themselves!

Outcrops plotted on geological maps are largely inferred. It is not possible to trace them continuously. In the field, the geologist also measures dips and takes into account the effects of structure on outcrops, even where he must largely infer the outcrops. Only when conditions are so obscure that faults and other structural features are not detected, will the true outcrop be far from its inferred position. However, lack of structure knowledge may result in some generalized outcrops, "fitted to" topography, indicating outcrops that actually are displaced or are not even present.

The topographic "fitting" process was necessary over practically all the four coalfields. It is hoped the inadvertant outcrop lengthenings and shortenings, will cancel each other out. Outcrops cut in or out by faults and revealed or buried in unknown structures are, however, very hard to assess.

BED THICKNESS

Coalbed thickness information comes from measurements at outcrops in the field, in drifts and strip pits and from drill holes and test pits. Unfortunately, in regional reserve estimates there is not time to do any field work or even to collect all information that may already exist. Final resort is principally to published material. Fortunately, McCalley (19) gave much thickness data in the Warrior coalfield. Butts (7,8,9,10,11) gave representative sections and estimates of probable "average" thickness for various beds in different areas. Prouty (20) gave fewer bed thicknesses in the Coosa coalfield but Rothrock (21) collected excellent data, easily enough from which to calculate strippable reserve estimates for the important northern end of the field. Martin (18) presented excellent data for a small area of Franklin, Marion, and Winston counties. Shotts and Riley (26) collected ample data in most of the Jackson county area they covered. However, data are quite scarce for the unmined, generally thin, coal areas of Walker and Fayette Counties.

As a result of coal reserve studies made for private companies in Bibb and Marion Counties and for the University of Alabama in both the

furnished all the information needed for strippable reserve estimates when replotted on 1:24,000 topo maps with 20-ft contours.

Other maps that carry information of limited use, are:

(1) Two maps accompanying a report on Stevenson and Scottsboro quadrangles (4). (2) Small scale maps of areas on Lookout Mtn. (12). (3) A map accompanying report on Blount Mtn. (14). (4) A small outcrop map near Brilliant, Ala. (22). (5) Upper Warrior coalfield maps (23). (6) Revised map of the Southeastern Part of the Cahaba Coalfield (28). (7) Map of part of Marion, Franklin and Winston counties (18). (8) Small scale maps in report on total remaining coal reserves of Alabama (13). These maps serve to limit, roughly, areas of known mineable coal on most coalbeds.

Some other geological maps, including the new Geological Survey of Alabama county series, are fine for general geology but without contours and without coalbed or "marker" bed outcrops, they are of little value in making reserve estimates.

The most copious and useful material from which to construct regional coal reserve estimates are in the files and on the maps of many coal and mineral land companies. Of course some rather large coal-bearing areas are not covered by these maps but they are generally the least promising areas. Since data from company sources are slow in appearing in the literature, most of the coal will be mined before the bulk of the data can be used for coal reserve estimates!

STRUCTURE

Coalbed outcrops are greatly influenced by structural features. Faults initiate as well as terminate coalbed outcrops and the combination of erosion patterns and folds results in greatly lengthening them. Fault traces, fold axes and structure sections are carried on all Butts' maps and on the Coosa field maps. Few other maps emphasize structural features. A small scale map compiled by C. S. Blair (22) shows much of the faulting in the Warrior field. No doubt, most of it was revealed in mining operation.

BED OUTCROPS

In order to estimate strippable coal reserves on a regional basis it is necessary to locate the coalbed outcrops with fair accuracy, to have some definite bed thickness information and to be able to estimate average coalbed dip and topographic slope. Without coalbed outcrops, the other information is rather useless.

A large-scale topographic map carrying coalbed outcrops is the ideal base for strip coal reserve estimates. Only for the small Marion-Franklin-Winston County area is there such a map (18) and it is not generally available! Butts' maps almost reach the ideal but the scale is so small and the outcrop lines necessarily so generalized that they are hard to relate to the topography. Contour intervals in excess of 20 feet make the relation even more tenuous.

Strippable Coal Reserves of Alabama

Of course, often no connection between topography and outcrop is evident at all. If the outcrops are reasonably accurate, even if highly generalized, they may be "fitted" to topography with fair accuracy. If an occasional true outcrop elevation is known, the accuracy is greatly increased. Small drift mine and strip mine symbols fix the bed elevation closely. Recent topographic maps usually show many of these symbols in coal mining areas but older ones usually show only the location of surface structures at the larger mines. The recent, 1967 map of the Carbon Hill quadrangle shows no abandoned strip mines although it is quite certain that some stripping has been done. As attempts were made to fit the complex outcrop pattern of McCalley's (19) map to the topography, it was noticed that some outcrops lay near numerous small ponds. It suddenly became evident that these ponds were really small strip pits on bed outcrops that were so old and overgrown that the field-check engineers failed to recognize them as such! Thus, it is evident that sometimes if one only has the patience and time scale of the geologist, he realizes that many environmental disturbances will heal themselves!

Outcrops plotted on geological maps are largely inferred. It is not possible to trace them continuously. In the field, the geologist also measures dips and takes into account the effects of structure on outcrops, even where he must largely infer the outcrops. Only when conditions are so obscure that faults and other structural features are not detected, will the true outcrop be far from its inferred position. However, lack of structure knowledge may result in some generalized outcrops, "fitted to" topography, indicating outcrops that actually are displaced or are not even present.

The topographic "fitting" process was necessary over practically all the four coalfields. It is hoped the inadvertant outcrop lengthenings and shortenings, will cancel each other out. Outcrops cut in or out by faults and revealed or buried in unknown structures are, however, very hard to assess.

BED THICKNESS

Coalbed thickness information comes from measurements at outcrops in the field, in drifts and strip pits and from drill holes and test pits. Unfortunately, in regional reserve estimates there is not time to do any field work or even to collect all information that may already exist. Final resort is principally to published material. Fortunately, McCalley (19) gave much thickness data in the Warrior coalfield. Butts (7,8,9,10,11) gave representative sections and estimates of probable "average" thickness for various beds in different areas. Prouty (20) gave fewer bed thicknesses in the Coosa coalfield but Rothrock (21) collected excellent data, easily enough from which to calculate strippable reserve estimates for the important northern end of the field. Martin (18) presented excellent data for a small area of Franklin, Marion, and Winston counties. Shotts and Riley (26) collected ample data in most of the Jackson county area they covered. However, data are quite scarce for the unmined, generally thin, coal areas of Walker and Fayette Counties.

As a result of coal reserve studies made for private companies in Bibb and Marion Counties and for the University of Alabama in both the

Warrior and Cahaba coalfields, the author has accumulated considerable data not in the literature, including some localized maps from company sources and some field measurements. All these data were used although all cannot be reproduced or credited. In spite of the wide variety of sources there are still coalbeds and areas for which measurements are so scarce that reserve estimates may be rather wide of the true tonnage available. Like most estimates, this one was kept on the conservative side so that true, ultimate resources will almost certainly prove to be greater than the estimated total.

TOPOGRAPHIC, SLOPES, COVER AND STRIPPING AREA

Once a coalbed outcrop has been accurately located on an adequate topographic map and the nature of the overburden and the capacity of equipment used to estimate economic overburden removal depth are known, calculations of the areas to be stripped, the volumes and tonnages to be removed and the tons of coal in place, are readily made. Even a good 1:24,000 topographic map is on too small a scale to give anything more than an approximate estimate, but for regional estimations they are adequate.

Figure 4a shows the relation between bench width and maximum overburden depth as influenced by slope of terrain and by coalbed dip. In areas of practically horizontal or slightly dipping beds, the dip factor can be ignored. This condition holds for most of the Warrior and Plateau coalfields. In the Cahaba and Coosa fields, however, the dips are 5° to vertical and beds "take cover" rapidly. As an illustration, the measured dip in a strip pit near Blocton No. 11 mine, Cahaba field, was about 18° . Assuming a place where the rise in topography is 60 ft in 300 ft or $11^{\circ}20'$ and the coalbed horizontal, the width of the bench that can be mined with maximum overburden of 75 ft is: $75/\tan 11^{\circ}20' = 75/0.200 = 375$ ft. With the bed dipping 18° , however, the width is only $75/(\tan 11^{\circ}20' + \tan 18^{\circ}) = 75/(0.200 + 0.325) = 143$ ft. For a bed 3 ft thick as the Woodstock bed is at this place, a 100-ft length of pit will uncover 4650 tons of coal if 375 ft wide and only 1700 tons, if 143 ft wide.

One error that creeps into the conditions and formula of Figure 4a is the assumption that the high wall is absolutely vertical. This is never quite true. If the highwall top is 300 ft back of the outcrop, its bottom may be only 295 ft and the stripping bench thus is only 295 ft wide. However, this may be offset by another assumption and that is that the slope of the overburden is uniform. If the slope is concave upward, the volume of overburden actually removed is less than that calculated. If it is convex upward, it is more (Fig. 4b). Figure 4c shows three actual profiles measured from a topographic map in Sections 9 and 10, T17S R6W Jefferson county, where Peabody Coal Company has mined the Gwin bed with highwalls probably up to 90 ft high.

In brief, the method actually used to compute bench width from an assumed 60-ft highwall (coal under 28-in. or thicker) was: (a) Measure length of outcrop with a map measurer. (b) Check topographic slopes in several places, at least one in each section. If a topographic map has areas of greatly contrasting slopes, the areas would be measured separately. (c) Take the "average" slope and apply in the formula in Figure 4a. This

Strippable Coal Reserves of Alabama

finally was reduced to a few "standard" values such as,

<u>$\tan\alpha + \tan\beta$</u>	<u>bench width</u>	<u>$\tan\alpha + \tan\beta$</u>	<u>bench width</u>
0.1	600	0.4	150
0.2	300	0.5	120
0.3	200	0.7	85

These values are for a 60-ft highwall and can be doubled for a 120-ft highwall.

In essentially level coal and land slopes under 5° , the bench width is greater than 600 ft. A 60-ft contour above the outcrop can be drawn and the area between the outcrop and this contour measured with a planimeter. (d) Bench width x outcrop length \div 43,560 gives acres and acres x 1800 x bed thickness, in feet, will give tons in place (assuming 1800 tons per acre-ft).

In the case of a very sinuous outcrop, this result will be too high. The length of the inside of the pit, or the face, is generally shorter than the outcrop because around hills and spurs the curvature is generally convex and less sharp than in reentrant valleys. No correction was made for this factor, however, because outcrops roughly fitted to topography are generally straighter than actual outcrops and thus shorter. This problem could stand some study using accurately drawn outcrops on large scale topographic maps.

ORIGINAL STRIPPABLE RESERVES

Although Culbertson's (13) modern estimate of total coal reserves places Alabama ahead of a number of coal producing states, very little has been done to date toward regional estimates of strippable reserves for the State. Shotts and Riley (26) estimated 40,001,000 tons of original reserves under 60 ft, or less; of cover in the Fabius-Flat Rock area of Jackson county. This was not a county total but covered virtually the only area in which sufficient information was available from which to make an estimate. Large-scale strip mining began in the area in 1964 and it has been depleted since that year by 2-1/2 - 3 million tons.

Shotts (25) estimated almost 19 million tons remaining strippable reserves, as of 1968, in Bibb County. This estimate was based on older and less reliable data than that for Jackson County and is, therefore, more uncertain. Because of considerable "patchy" to complete Cretaceous cover, steep dips, beds of irregular thickness and a very large number of beds, the ultimate strippable reserve under the assumptions made in this study is likely to exceed 19 million tons.

Tables 2 and 3 show the remaining total reserves (1958) of bituminous coal and the original strippable reserves by counties and by coalfields in Alabama. All figures are for original strippable reserves, in place, except for Bibb county. The previous Bibb and Jackson county totals were

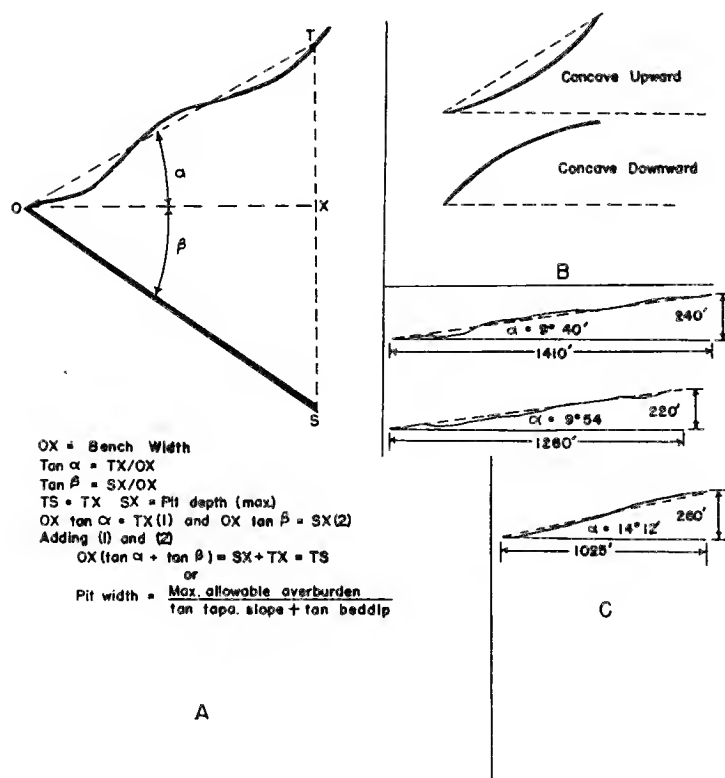


FIGURE 4. Coalbed dip and topographic slope elements used in strippable reserve study.

included in spite of the fact, as noted above, that Jackson county total is undoubtedly larger than that of the Fabius-Flat Rock area.

Figures for total remaining reserves as of January 1, 1958, were taken unchanged from Culbertson (13), with the following exceptions:

(1) Estimates of total reserves for the Bear Creek bed in Franklin, Marion and Winston counties, were added.

(2) An estimate of reserves on the Gwin bed for Walker and Tuscaloosa counties was added. One mine is operating in this area now but Culbertson knew nothing of the existence of the reserve in 1958. The author saw a few outcrops in 1961 (24) and saw the coal in one active pit in 1969. The estimates are based on very tenuous data but since several hundred thousand tons of coal have been mined in the southwest part of the Tutwiler School quadrangle, there is certainly some coal present! U. S. Steel and Peabody Coal Company geologists call the bed the Clements but the author considers it to be the Utley or Gwin. In 1961, the Gwin bed was favored and that designation is used here but the author has more doubts now.

(3) The Utley bed is being mined in about four areas in Jefferson county rather than in one as in 1958, so the total reserve for that county has been increased - again based upon rather meager data. In the total, these additions are really quite small.

Strippable Coal Reserves of Alabama

TABLE 2. Remaining reserves of coal in Alabama, in beds 14-inches or more in thickness as of January 1, 1958 (13), and original strippable reserves (present estimate) by counties; millions of tons.

County	Total reserves		Strippable reserves		% of strip reserves
	+ 28"	14" x 28"	+ 28"	14" x 28"	
Bibb	372.9	290.5	19.595	2.055	2.8
Blount	7.4	14.9	0.540	16.659	2.2
Cherokee	-	10.4	-	0.235	0.0
Cullman	43.6	96.5	16.565	13.492	3.9
DeKalb	1.6	15.1	-	-	0.0
Etowah	3.2	2.6	1.518	-	0.2
Fayette	513.3	588.7	13.740	15.840	3.8
Franklin	-	13.3	-	8.628	1.1
Jackson	72.7	0.3	39.721	0.280	5.1
Jefferson	1220.7	2695.2	101.738	48.774	19.3
Marion	154.2	135.6	-	20.279	2.6
St. Clair	41.8	43.9	7.332	1.213	0.9
Shelby	468.5	364.9	7.478	1.792	1.2
Tuscaloosa	2558.9	952.9	50.776	16.220	8.6
Walker	1770.8	1660.3	142.041	213.033	45.5
Winston	8.7	51.9	-	20.571	2.6
<hr/>					
State Total	723.83	6937.0	401.044	379.071	
<hr/>					
	14,175.3		780.115		100.0

TABLE 3. Remaining reserves of coal in Alabama in beds 14-inch or more thickness as of January 1, 1958 (13), and original strippable reserves (percent estimate), by coalfield; millions of tons.

Coalfield	Total reserves		Strippable reserves		% of strip reserves
	+28"	14" x 28"	+28"	14" x 28"	
Cahaba	982.0	746.3	39.892	4.436	5.7
Coosa	31.0	27.4	2.359	1.025	0.4
Plateau	83.1	31.4	41.779	4.419	5.9
Warrior	6142.2	6131.9	317.014	369.191	88.0
	7238.3	6937.0	401.044	379.071	100.0
Total	14,175.3		780.115		100.0

Table 2 shows a total reserve of 14,175.3 million tons as against 13,153.8 millions tons estimated by Culbertson (13) as of 1958. The gain is much less than this as about 175 million tons of coal has been mined in the State since 1958.

Note that both total and strippable reserves are divided into thickness categories of plus 28 in. and 28 by 14 in. All coal thinner than 14 in. is excluded although it is being mined in the State in places. These places are usually in areas of multiple-seam mining.

Although Table 2 shows strippable reserves in 16 counties, almost half is in Walker county and 64.8% in Walker, Jefferson, and Tuscaloosa counties. Only slightly more than 50% of the strippable reserves are in beds more than 28-in. thick. Total original strippable reserves make up 5.5% of the remaining estimated total reserves. This is not a satisfactory comparison. Figure 2 indicates about 75 million tons of coal have been stripped in the State to date. A study by the Bureau of Mines in 1966 found that strip coal recovery runs about 80%. This figure has been used although the final report has not been published. Applying this figure to past production, strippable reserves have been depleted by 94 million tons. Undoubtedly, some strippable coal under the definitions used has been underground-mined and much of the 10 million tons mined by augering may also have been strippable. This tonnage is very hard to estimate and is, within itself, a problem that deserves some study. However, as a "guess", if a maximum tonnage of 125 million has been depleted, this means 655 million tons remain. This is only 4.6% of the total remaining reserves.

Strippable Coal Reserves of Alabama

LITERATURE CITED

1. Alabama State Department of Public Relations. Annual Statistical Report of the Division of Safety and Inspection. Pub. annually since 1940.
2. _____. Annual Report. Published annually, 1905-1939 (1932 and 1933 in office manuscript only).
3. Alabama State Mine Inspector. Biennial Report. Pub. Biennially, 1893-1904.
4. Barksdale, J., R. Q. Shotts, and C. V. Rice. 1934. Occurrence of coal on Cumberland Mountain in Jackson and adjacent counties and on Sand Mountain in Jackson and DeKalb counties. TVA Mss. Rept., TVA Fuels Planning Section, open file, Chattanooga, Tenn.
5. Bureau of Mines. Mineral Resources of the United States. Calendar yrs. 1924-31. Pub. 1927-34.
6. Bureau of Mines, Minerals Yearbook. Pub. annually following 1933 ed. publ. in 1933.
7. Butts, C. 1907. The northern part of the Cahaba coal field, Ala. Contributions to Economic Geology, 1906, U. S. Geol. Survey Bull. 316:76-115
8. _____. 1910. Birmingham, Ala. Geologic Atlas of the United States, U. S. Geol. Survey Folio 175.
9. _____. 1911. The southern part of the Cahaba field, Ala. Contributions to Economic Geology 1909, U. S. Geol. Survey Bull. 431:89-146.
10. _____. 1927. Bessemer-Vandiver, Ala. Geologic Atlas of the United States, U. S. Geol. Survey Folio 221.
11. _____. 1940. Montevallo-Columbiana. Geologic Atlas of the United States, U. S. Geol. Survey Folio 226.
12. Coulter, D. M. 1947. Coking coal deposits on Lookout Mountain, DeKalb and Cherokee Counties, Ala. Bureau of Mines Rept. of Inv. 4030.
13. Culbertson, W. C. 1964. Geology and coal resources of the coal-bearing rocks of Alabama. U. S. Geol. Survey Bull. 1182-B.
14. Gibson, A. M. 1893. Report on the coal measures of Blount Mountain. Alabama Geol. Survey Spec. Rept. 5.
15. Hayes, C. W. 1895. Stevenson, Ala.-Ga.-Tenn. Part of Geologic Atlas of the United States, U. S. Geol. Survey Folio 19.

16. _____. 1896. Gadsden, Ala. Part of Geologic Atlas of the United States, U. S. Geol. Survey Folio 35.
17. Jones, W. B. 1929. Summary report on the Wattsville Basin of the Coosa coal field. Alabama Geol. Survey Circ. 6.
18. Martin, R. G., Jr. 1962. Geology of a portion of Franklin, Marion and Winston Counties, Alabama. M.S. Thesis, U. of Tennessee, Knoxville.
19. McCalley, H. 1899. Map of the Warrior coal basin with columnar sections. Alabama Geol. Survey.
20. Prouty, W. F. 1912. Map of the Coosa coal field, with sections. Alabama Geol. Survey map.
21. Rothrock, H. E. 1949. Geology and coal resources of the northeast part of the Coosa coal field, St. Clair County, Alabama. Alabama Geol. Survey Bull. 61.
22. Semmes, D. R. 1929. Oil and gas in Alabama. Ala. Geol. Survey Spec. Rept. 15.
23. Shotts, Reynold Q. 1953. A report on the reserves of coal in a part of the Warrior field of Alabama. TVA Fuels Planning Section, open file, Chattanooga, Tenn.
24. _____. 1967. The Utley coal bed in the western Warrior field. J. Ala. Acad. Sci. 38:203-214.
25. Shotts, Reynold Q. 1972. Coal reserves of Bibb County, Alabama. Geol. Survey of Ala., Circ. 72.
26. Shotts, Reynold Q. and H. L. Riley. 1966. Coal resources of the Fabius-Flat Rock area, Jackson County, Alabama. Bureau of Mines Inf. Circ. 8295.
27. Squire, J. 1890. Report on the Cahaba field. Alabama Geol. Survey, Special Rept. 2.
28. Smith, E. A. 1905. Revised map of the southeastern part of the Cahaba coal field; Compiled mainly from map of J. Squire and field Notes by G. H. Brewer. Alabama Geol. Survey 1905.
29. U. S. Geological Survey. Mineral Resources. Annual volumes published giving statistics for years 1882 to 1923.

Changes in Student Values

CHANGES IN STUDENT VALUES DURING TWO YEARS OF COLLEGE

John W. Yeates
Florence State University
Florence, Alabama

INTRODUCTION

A persistent interest of those concerned with the personal growth of college students is how much students modify their value orientations during college years. There are hints that recent changes have taken place in the value commitments of those who have attended college.

After extensive study in 1957, Jacob (4) concluded that the college student's basic values remained, for the most part, constant throughout his educational experience. A similar observation had been made two decades before by Whitely (7). However, in 1968, members of the staff of the Center for Research and Development in Higher Education at the University of California at Berkeley (3) did a follow-up study of 10,000 high school graduates to compare value changes of those who did and did not attend college. They found that college students showed increased interest in ideas, in a willingness to tolerate ambiguities, and in a growth of nonauthoritarian attitudes. Moreover, those who became housewives or who took jobs immediately after high school often regressed in the above-mentioned value stances.

Accentuating the influence of the collegiate experience upon personal values, Keniston (5) has identified the extension of higher education as one of the critical historical pressures which cause youth to question their pre-existing attitudes and opinions.

MATERIALS AND METHODS

Value changes in a group of students were studied over a two year period at Wood Junior College, a private, church-supported institution located at Mathiston, Mississippi. The instrument used in the study was that of Allport *et al.* (1). This scale for measuring six basic interests in personality has been in use for approximately 40 years and is based upon the theories of Eduard Spranger (6). The six values measured by the instrument and their summaries are: (1) Theoretical; the main interest is the intellectual pursuit of truth. (2) Economic; this is characterized by an emphasis upon the practical and the useful. (3) Aesthetic; the highest values here are form, harmony, and beauty. (4) Social; the emphasis is upon altruistic love for people. (5) Political; power, competition, and leadership are dominant. (6) Religious; the highest value is finding a mystical, divine meaning in every aspect of life.

Each value measured has a hypothetical mean of 40, and the values are relational. Any gain or loss in one value necessitates a change in another value. Furthermore, the instrument calls for forced choices; so, nihilism cannot be measured.

The Study of Values was administered to 34 males and 30 females who entered college in 1968. Of those who remained to be tested near the completion of junior college in 1970, 15 males and 8 females had usable scales.

RESULTS AND DISCUSSION

Group means for males (Table 1) and females (Table 2) were calculated. Means for the males in this study were below the national means in theoretical, economic, aesthetic, and political values for both administrations. But the males exceeded the norm in social and religious values for both administrations. Theoretical values were significantly lower than the national norm, and religious values were significantly higher. The authors of the test define significance as a mean that falls outside the range which includes 50% of the scores.

For the females, theoretical, aesthetic, and political values were below the national norm for both administrations. Economic, social, and political values exceeded the norm both times. Means for the females differed significantly from the norm in high religious values and low aesthetic values.

Over the two year period, means for the males declined in theoretical, economic, and social values and rose in aesthetic, political, and religious values (Table 1). Means for the females declined in political and religious values and rose in economic, aesthetic, and social values. The theoretical value mean for the females was unchanged (Table 2).

TABLE 1. Means, standard deviations, and coefficients of correlation for male students.

Values	First Year		Second Year		r.
	<u>Mean</u>	<u>s.d.</u>	<u>Mean</u>	<u>s.d.</u>	
Theoretical	39.5	3.6	38.8	6.0	.02
Economic	40.1	5.5	39.9	8.2	.50
Aesthetic	32.8	7.2	34.2	8.8	.10
Social	40.6	8.3	38.2	6.1	.43
Political	41.1	4.6	41.7	5.7	.16
Religious	45.8	7.0	47.1	7.7	.31

Changes in Student Values

TABLE 2. Means, standard deviations and coefficients of correlation for female students.

Values	First Year		Second Year		r.
	<u>Mean</u>	<u>s.d.</u>	<u>Mean</u>	<u>s.d.</u>	
Theoretical	34.8	6.3	34.8	8.5	.62
Economic	36.9	4.5	37.7	4.0	.64
Aesthetic	35.4	4.2	35.9	5.0	.74
Social	44.4	4.3	45.8	3.8	.44
Political	35.9	4.6	34.9	5.6	.44
Religious	52.8	4.9	50.9	5.3	.55

The ordinal rankings of values (Table 3) show that females and males were quite similar in their hierarchy of values at the beginning of college. They differed only in the interchange of theoretical and aesthetic values. However, the second administration of the scale showed more pronounced changes for males than for females. For males, religious, economic, and aesthetic values remained constant in their relative positions. Political values advanced two positions displacing social values, and theoretical values advanced one position. Social values changed the most in the rankings, dropping three positions.

For the females, rankings calculated from the second administration differed from those of the first only in that aesthetic values were raised one position, and political values were lowered to the position previously occupied by aesthetic values.

The data are somewhat difficult to interpret, but indicate that males made more value shifts than females in the first two years of college. The males had more shifts in their ordinal rankings of values. Furthermore, they showed more individual changes as shown by the standard deviations and the product-moment coefficients of correlation of the scores of both administrations.

Individual changes were more evident than group changes. The relative stability of the means has often obscured this fact in previous studies. For most of the values, the standard deviations increased in this study. This contradicts the idea that college students become more alike in their values. The data show that both males and females became more like their fellow students of the same sex only in social values. Females also became more alike in economic values.

TABLE 3. Ordinal rankings of values.

Values	First Year		Second Year	
	<u>Males</u>	<u>Females</u>	<u>Males</u>	<u>Females</u>
Theoretical	5	6	4	6
Economic	3	3	3	3
Aesthetic	6	5	6	4
Social	2	2	5	2
Political	4	4	2	5
Religious	1	1	1	1

The more stable values for females were the aesthetic, the economic, and the theoretical. For the males, the more stable values were the economic, the social, and the religious.

The most stable values for the collective group were the economic values since they retained their position in the ordinal rankings for males and females and showed comparatively high coefficients of correlation.

Finally, one should be cautious in attempting to identify values of one group of students by using projections from another student population. Each student body has its own character. Arsenian (2) has pointed out that a college tends to attract and to retain those students who accept the institution's particular philosophy. If this is the case, the usefulness of any study in values may be questioned outside the institution in which the study took place.

This study raises certain questions about the kinds of students who go to junior colleges. Are they different in their value orientations from those who go to senior colleges? Are they more or less susceptible to value changes than are students elsewhere? Further study is needed to answer these questions.

LITERATURE CITED

1. Allport, G. W., P. E. Vernon, and G. Lindzey. 1960. Manual: study of values. 3rd ed. Houghton Mifflin Co., Boston.
2. Arsenian, S. 1943. Change in evaluative attitudes during four years of college. J. Appl. Psychol. 27:338-349.

Changes in Student Values

3. College influence on student values. 1968. Phi Delta Kappan 40:57-59.
4. Jacob, P. E. 1957. Changing values in college. Harper and Brothers, New York.
5. Keniston, K. 1970. Student activism, moral development, and morality. Am. J. Orthopsychiatry 40:577-592.
6. Spranger, E. 1928. Types of men. Tr. by P. J. W. Pigors. Max Niemeyer Verlag, Halle.
7. Whitely, P. L. 1938. The constancy of personal values. J. Abnorm. Soc. Psychol. 33:405-408.

A SURVEY OF THE GREEN ALGAE INHABITING
A STREAM IN MOBILE, ALABAMA

Margaret W. Miller
University of South Alabama
Mobile, Alabama

INTRODUCTION

This is a preliminary report of the filamentous, non-flagellated unicellular and colonial Chlorophyta (green algae) inhabiting a stream in Langan Park, Mobile County, Alabama. A survey of the literature revealed no list of the freshwater algae of Mobile County or of Alabama although lists of the algal flora of other southeastern states and the southern United States have been published (1,2,3,6,8,9,11,12).

This survey was designed to identify the genera of algae inhabiting a spring-fed stream in Langan Park (Sections 24 and 20) from April, 1967 to June, 1969.

MATERIALS AND METHODS

Four collecting sites were randomly selected between the head of the stream and the first dam. Algal collections were made at weekly intervals during spring, summer, and fall 1967-69. Collections were made with a small plankton net which was drawn across the water approximately four times, each time reversing the direction of the sweep. Separate samples were brought to the laboratory in bottles and either immediately centrifuged and the algae identified or were stored in a controlled environmental chamber until centrifugation and identification could be made. No sample was stored longer than four or five days after collecting. Two slides were made of each concentrated sample for examination with a microscope; references used for identification included those by Smith (10), Prescott (4,5) and Ralfs (7).

RESULTS AND DISCUSSION

The genera of algae collected were: Division Chlorophyta, Class Chlorophyceae, Order Ulothrichales, Family Ulothrichaceae, *Ulothrix* Kützinger, 1833; Order Oedogoniales, Family Oedogoniaceae, *Oedogonium* Link, 1820, and *Bulbochaeta* Agardh, 1817; Order Cladophorales, Family Cladophoraceae, *Cladophora* Kützinger, 1843; Order Chlorococcales, Family Dictyosphaeriaceae, *Dimorphococcus* A. Braun, 1855; Family Hydrodictyaceae, *Pediastrum* Meyen, 1829, and *Sorastrum* Kützinger, 1845; Family Coelastraceae, *Coelastrum* Nägeli, 1849; Family Oöcystaceae, *Ankistrodesmus* Corda, 1838, *Closteridium* Reinsch, 1888, and *Selenastrum* Meyen, 1829; Family Scenedesmaceae, *Scenedesmus* Meyen, 1829, and *Actinastrum* Lagerheim, 1882; Order Zygnematales, Family Zygnemataceae, *Mougeotia* Agardh, 1824, and *Spirogyra* Link, 1820; Family Mesotaeniaceae, *Netrium* Nägeli, 1849, and *Spirotaenia* de Brebisson, 1848; Family Desmidiaceae, *Closterium* Nitzsch, 1817, *Penium* de Brebisson, 1844, *Pleurotaenium* Nägeli, 1849, *Docidium* de Brebisson, 1844, *Euastrium* Ehrenberg, 1832, *Cosmarium* Corda, 1834, *Micrasterias* Agardh, 1827, *Xanthidium* Ehrenberg, 1837, *Staurastrum* Meyen, 1829, *Arthrodesmus* Ehrenberg, 1838,

Green Algae in Mobile

Onychonema Wallich, 1860, *Spondylosium* de Brebisson, 1844, *Hyalotheca* Ehrenberg, 1841, *Desmidium* Agardh, 1825, and *Sphaerososma* Corda, 1834.

Species of *Ankistrodesmus*, *Scenedesmus*, *Dimorphococcus*, *Micrasterias*, *Cosmarium*, *Mougeotia*, *Pediastrum*, *Staurastrum*, and *Spirogyra* were present in every collection. In addition to the green algae, diatoms were universally present in the samples collected as well as members of the Cyanophyta--*Oscillatoria* and *Anabaena*. At times, *Euglena*, *Phacus*, *Synura*, and dinoflagellates were encountered.

No list was kept of the non-motile green algae, i.e. *Gonium*, *Pandorina*, *Volvox*, *Chlamydomonas*, since they did not survive long after collection.

During the two year span of this study, *Spirogyra* became increasingly abundant, whereas *Oedogonium* and *Cladophora* became rare. At times, collecting station 1 contained mats of *Spirogyra* entangled in the cattails in the stream.

The greatest number and variety of algal genera appeared in the fall with about equal numbers of genera occurring in the spring and summer.

LITERATURE CITED

1. Dillard, Gary D. 1967. The freshwater algae of South Carolina. I. Previous work and recent additions. J. Elisha Mitchell Sci. Soc. 83:128-131.
2. Gier, L. J. and Martha Johnson. 1954. Algae of Missouri. Trans. Kansas Acad. Sci. 57:78-80.
3. McNeill, Ellis Meade. 1948. A contribution to the knowledge of West Virginia Algae. Castanea. 13:1-53.
4. Prescott, G. W. 1962. Algae of the western Great Lakes area. W. C. Brown Co., Inc., Dubuque, Iowa.
5. _____. 1964. How to know the freshwater algae. W. C. Brown Co. Inc., Dubuque, Iowa.
6. _____ and A. M. Scott. 1942. The freshwater algae of southern United States. I. Desmids from Miss. with descriptions of new species and varieties. Trans. Amer. Microsc. Soc. 61:1-29.
7. Ralfs, J. 1962. The British Desmidiaceae. Hafner Publishing Co., New York, N. Y.
8. Schumacher, G. J. and L. A. Whitford. 1961. Additions to the freshwater algae in N. C. J. Elisha Mitchell Sci. Soc. 77:274-280.
9. Silva, H. and A. J. Sharp. 1944. Some algae of the southern appalachians. J. Tenn. Acad. Sci. 19:337-345.

Journal of the Alabama Academy of Science

10. Smith, G. M. 1950. The freshwater algae of the United States. 2nd Ed. McGraw Hill Book Co. Inc., New York, N. Y.
11. Whitford, L. A. 1956. The communities of algae in the springs and spring streams of Florida. Ecology 37:433-442.
12. Woodson, Bernard R. and Verna Holoman. 1965. Additions to the freshwater algae in Virginia. Virginia J. Sci. 16:146-164.

Boron Deficiency Symptoms on *Hibiscus*

BORON DEFICIENCY SYMPTOMS ON *HIBISCUS ROSA-SINENSIS*, 'SINGLE RED'

Thomas Cochis, George H. Snyder and Kenneth E. Landers

Department of Biology
Jacksonville State University, Jacksonville, Alabama
and
Everglades Experiment Station
Belle Glade, Florida

INTRODUCTION

Aguljon (1,2) in 1910 was one of the first to report that boron was essential for the growth of higher plants. Since this time, numerous papers have been written on the effect of boron deficiency on higher plants. However, deficiency symptoms on *Hibiscus rosa-sinensis* have not been reported.

MATERIALS AND METHODS

This test was conducted at the Plantation Field Laboratory, a research branch of the University of Florida at Fort Lauderdale, Florida.

Rooted cuttings of *H. rosa-sinensis* 'Single Red' were used. The boron deficiency test was part of a project involving deficiency and excess symptoms of several major and minor elements. A complete Hoagland's solution (3) was used to irrigate control plants; nutrient solution modified to eliminate boron was used as the deficient treatment. Nutrient solutions were percolated twice daily through an inert medium of vermiculite and Perlite. Plastic-lined clay pots were fitted with rubber tubing through the drainage holes which led to collection bottles. Solutions were reused after adding distilled water to compensate for loss by transpiration and evaporation. The solutions were replaced twice during the 90 day course of the experiment.

The plants received normally-accepted cultural practices for the control of insects and diseases and were grown outdoors during the summer months. At the end of the test, color slides were made of the affected plants. Leaf samples were taken from 5 deficient plants and 2 control plants. Samples were separately washed in distilled water, oven dried at 60 C for 24 hr, crushed, weighed and ashed in a muffle furnace at 600 C for 6 hr. Ashes were dissolved in 5 ml of a 0.36 N H₂SO₄ and centrifuged. Five 1 ml samples were taken for boron analysis of each leaf sample by the quinalizarin colorimetric method described by Jackson (4).

RESULTS

At the end of the experiment, leaves of the boron-deficient plants were severely cupped and split at the margins. The plants were generally stunted and appeared to be a very dark green when compared to the controls. Boron content of leaves of the control plants averaged 27.0 ppm, whereas

that of deficient plants averaged 5.4 ppm. The small amount of boron found in the deficient plants probably was already present in the rooted cuttings.

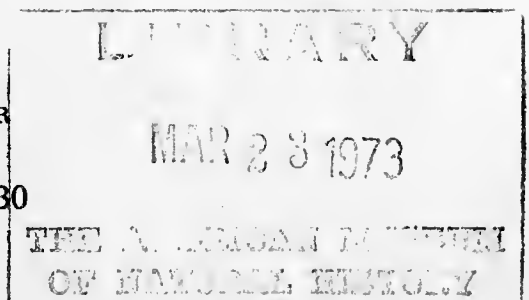
LITERATURE CITED

1. Aguljon H. 1910. Research on the presence and role of boron with vegetable plants. PhD thesis, Univ. of Paris.
2. _____. 1910. Use of boron as a catalytic fertilizer. *Compt. Rend. Acad. Sci.* 150:288-291.
3. Hoagland, D. R. and D. I. Arnon. 1938. The water-culture method for growing plants without soil, Univ. of Cal. Agriculture Experiment Station. Circ. 347.
4. Jackson, M. L. 1958. Soil chemical analysis. Prentice Hall, Englewood Cliffs, N. J.

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

**AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE**

**OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830**



VOLUME 42

JULY, 1971

NUMBER 3

Officers of the Alabama Academy of Science
1971-1972

	Tenure	Term Begins	Term Expires
PRESIDENT.....G. O. Spencer,	1 year	1971	1972
PRESIDENT-ELECT.....Joseph C. Thomas,	1 year	1971	1972
SECRETARY.....Thomas E. Denton,	1 year	1971	1972
TREASURER.....William F. Arendale,	3 years	1969	1972
EDITOR OF JOURNAL.....Elroy A. Curl,	Unexp.	1971	1972
COUNSELOR OF THE AAAS.....Roman Skorski,	3 years	1971	1974
PERMANENT COUNSELOR			
OF JUNIOR ACADEMY....James D. Welker,	3 years	1971	1974
ASSOCIATE COUNSELORS			
OF JUNIOR ACADEMY...Robert P. Bauman,	3 years	1971	1974
John W. Holland, Jr.,	3 years	1969	1972
COORDINATOR OF			
SCIENCE FAIRS.....G. O. Twellmeyer,	3 years	1971	1974
SECTION I--BIOLOGICAL SCIENCES			
Vice-President.....H. R. Cunningham			
Vice-Chairman.....J. S. Brown			
SECTION II--CHEMISTRY			
Vice-President.....Carlton P. Whitt			
Vice-Chairman.....Virgil M. Benson			
SECTION III--GEOLOGY			
Vice-President.....Michael W. Szabo			
Vice-Chairman.....Denny N. Bearce			
SECTION IV--FORESTRY, GEOGRAPHY, AND CONSERVATION			
Vice-President.....Merle Sherman			
Vice-Chairman.....John Bourne			
SECTION V--PHYSICS AND MATHEMATICS			
Vice-President.....Bernis Hannah			
Vice-Chairman.....J. Raymond Cooper			
SECTION VI--INDUSTRY AND ECONOMICS			
Vice-President.....Barry Mason			
Vice-Chairman.....Charles Leoins			
SECTION VII--SCIENCE EDUCATION			
Vice-President.....Mary Carlton			
Vice-Chairman.....Ernest Riggsby			
SECTION VIII--SOCIAL SCIENCES			
Vice-President.....Frances Roberts			
Vice-Chairman.....Wesley P. Newton			
SECTION IX--MEDICAL SCIENCES			
Vice-President.....Charles P. Dagg			
Vice-Chairman.....Fred Gilbert			
SECTION X--ENGINEERING			
Vice-President.....D. C. Raney			
Vice-Chairman.....John E. Cochran, Jr.			
SECTION XI--ANTHROPOLOGY			
Vice-President.....Karen Joines			
Vice-Chairman.....E. Earle Smith, Jr.			

BOARD OF TRUSTEES

Walter Bouldin, 1969-'72	E. V. Smith, 1970-'73
Lister Hill, 1969-'72	J. F. Fagen, 1971-'74
W. B. Jones, 1969-'72	Howard Milling, 1971-'74
J. F. Volker, 1969-'72	H. M. Philpott, 1971-'74
W. J. Barrett, 1970-'73	J. F. Sulzby, Jr., 1971-'74
H. E. Carr, 1970-'73	

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

VOLUME 42

JULY, 1971

NUMBER 3

EDITOR

Elroy A. Curl
Auburn University

ARCHIVIST

Clyde H. Cantrell
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman
Auburn University

Elroy Curl
Auburn University

Ann Everette
Crossville High School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ABSTRACTS

Biological Sciences	130
Chemistry	150
Geology	158
Forestry, Geography, and Conservation	168
Physics and Mathematics	172
Industry and Economics	174
Science Education	177
Social Sciences	180
Engineering	187
Anthropology	196
Addendum to Biological Sciences	204
ANNUAL BUSINESS MEETING MINUTES	205

Abstracts

ABSTRACTS

Papers presented at the 48th Annual Meeting
University of Alabama, Tuscaloosa
April 1-3, 1971

BIOLOGICAL SCIENCES

A MATHEMATICAL MODEL OF ALABAMA HERPETOFAUNAL PROVINCES

Franklyn W. Adams
Biology Department
Troy State University
Troy, Alabama

A quantitative method is used to reduce the subjective bias in analyzing the distribution of the herpetofauna of Alabama. A divergence factor is utilized to indicate the rate of species replacement in a given area. All geographical points having equal values are connected by a contour line. The resulting contour map indicates homogeneous regions in the Coastal Plain, the Tennessee Valley and Piedmont areas. Barriers are evident in the Fall Line and the Appalachian Mountain finger. Transitional zones are noted between the homogeneous regions and barriers.

PHYSIOLOGICAL INTERRELATIONS BETWEEN *HELIOTHIS ZEA* AND TWO IMPORTANT LARVAL PARASITOIDS

Donald J. Barras
Troy State University
Troy, Alabama

Microplitis croceipes was removed from *Heliothis zea* at varying intervals. The host continued to exhibit the usual parasitized behavior and did not pupate. When several *Microplitis croceipes* are oviposited in the host, the first parasitoid to hatch seemed to be the only one to survive, all other parasitoids became encapsulated and eventually died. This condition may be caused by chemical secretion by the first parasitoid or its teratocytes. This chemical control seemed to be effective for approximately 48 hr. Parasitoids oviposited in the host after this time will hatch and eventually take over the control of the host and result in encapsulation of earlier parasitoids. *Microplitis croceipes* apparently has some ability to avoid duplication of oviposition in a host in the field and have a more efficient distribution pattern than a random one. *Microplitis croceipes* apparently has a greater preference for stinging *Heliothis zea* than does *Cardiochiles nigriceps*.

A MODIFICATION OF THE p-NITROPHENYL- β -D-GALACTOPYRANOSIDE
METHOD FOR DETERMINATION OF β -GALACTOSIDASE ACTIVITY
IN SOIL COLONIZED BY *RHIZOCTONIA SOLANI*

H. Wayne Beam, R. Rodriguez-Kabana, and E. A. Curl
Department of Botany and Microbiology
Auburn University, Auburn, Alabama

A modification of the p-nitrophenyl- β -D-galactopyranoside method was used to determine β -galactosidase activity of *Rhizoctonia solani* (ATCC #14006) in soil culture. Autoclaved flasks of sandy loam soil supplemented with nutrient solution were inoculated with a chopped mycelial suspension of the fungus. Cultures were incubated at 27 C for 6 days, during which soil samples were removed periodically, air dried at room temperature, and stored at 7 C until analyses were performed.

For enzyme determinations, 2 g of soil and 2 ml of substrate (p-nitrophenyl- β -D-galactopyranoside) were added to 50-ml Erlenmeyer flasks. Appropriate control flasks containing only soil and water were included. The reaction was allowed to proceed for 4 hr at 37 C, then stopped by the addition of 6 ml of ethanol. Supernatant fluid from each flask was decanted and centrifuged for 20 min at 1500 g. Two-ml fractions of the supernatant were pipetted into tubes containing 8 ml of water, and the color was developed with the addition of 1 ml of 0.2 N NaOH. Optical density readings at 400 m μ were taken and used to determine enzymatic activity.

β -galactosidase activity generally increased with time. Optimal pH, produced with 0.1 M citrate and phosphate buffers, for enzymatic activity in soil was 5.5.

MAINTENANCE OF CLOSED CIRCUIT MARINE ENVIRONMENTS

Everett L. Bishop
University of Alabama, University

The development of controlled environmental factor marine systems permits experimental studies more precise than field studies.

A marine semiclosed-circuit system is described and illustrated. The critical factors permitting such a system to operate for many months or years include filter design and operation, and pH stability. Filtration utilizes a bacterial active surface layer which nitrifies ammonia and urea. The filtering material may be any form of reasonably hard limestone or shell, with particle size of $\frac{1}{2}$ to $\frac{1}{4}$ cu. cm. This serves the several purposes of catching and holding particulate matter from the tank water, forming a surface layer for the bacterial sludge, and holds the pH adequately alkaline (7.8-8.2).

The flow rate through the filters is approximately equal to tank capacity per hour or two. The use of air-lift pumping or peristaltic plastic tubing eliminates all metal from the system.

Using these principles, we have kept a variety of marine organisms in healthy condition for over two years. Several experimental studies are in progress.

Abstracts

BIOLOGICAL STUDIES OF THE FAMILY GLOSSOSOMATIDAE IN NORTHWEST ALABAMA

John R. Bourne
Florence State University
Florence, Alabama

Biological and ecological studies were conducted during the fall and winter of 1970 and the winter and spring of 1971 on *Glossosoma* sp., a mountain caddisfly, Family: Glossosomatidae.

The research area (Colbert Creek), a tributary of the Tennessee River, is located in west Lauderdale County approximately 1.5 miles north of the Natchez Trace Bridge connecting Lauderdale and Colbert Counties.

Physical and chemical measurements were made of the Colbert Creek research area and included ambient and water temperature plus determination of dissolved oxygen, carbon dioxide, water hardness, silica, iron, and pH values.

Concurrent biological studies included collection of the adult *Glossosoma* sp., determination of stone size and color preference by the grazing glossosomatid larvae, and analyses of stomach contents of the fifth larval instar.

EPISTYLIS (PROTOZOA: PERITRICA), A SYMBIONT ON THE STINKPOT, *STERNOTHERUS ODORATUS*

Jack S. Brown
Institute for Fresh-Water Biology
Florence State University
Florence, Alabama

A stinkpot turtle, *Sternotherus odoratus*, collected in November 1969 at Reelfoot Lake, Tennessee was almost completely covered dorsally and laterally with a "growth" identified as the colonial stalked ciliate protozoan, *Epistylis* sp. This organism has been reported as a disease-producing parasite in fishes. In the stinkpot, there was no evidence of damage to the skin or epidermal scales of the carapace. The infection diminished and finally disappeared while the turtle was kept in the laboratory.

A SURVEY OF THE MACROBENTHIC ORGANISMS IN AN INDUSTRIAL DISCHARGE EMBAYMENT

Jack S. Brown
Institute for Fresh-Water Biology
Florence State University
Florence, Alabama

In an effort to determine possible damage to the aquatic environment by past and present effluent from a Sheffield, Alabama industrial plant, 76 water and 136 bottom samples were collected at 9 stations on 5 days during December 1970 and January 1971. Six stations were in the

discharge embayment and 3 were in a nearby control embayment which has never received industrial discharge.

Similar populations of macrobenthic organisms were found in the two embayments. These include species of midge and phantom midge larvae; mayfly, dragonfly, and damselfly nymphs; aquatic oligochaetes; snails; and Asiatic clam.

The data obtained in this study indicate that the plant effluent has not produced effects adverse to the organisms in the discharge embayment with the possible exception of the Asiatic clam. The study is being continued and expanded.

A SURVEY OF THE INTERNAL PARASITES OF A FERAL HERD OF FALLOW DEER (*DAMA DAMA*) IN ALABAMA

Thomas H. Brugh, Jr.
Auburn University, Auburn, Alabama

A study was conducted to determine the species of internal parasites infecting the fallow deer (*Dama dama*). From August, 1969, through September, 1970, seven fallow deer were collected in Wilcox County, Alabama, and the parasites removed for identification. In addition to these fallow deer, two white-tailed deer were collected in the same area. The parasitic species of these two deer were also included in this study.

A total of seven genera of parasites was recovered from fallow deer. These parasites are as follows: *Gongylonema pulchrum*, *Setaria tundra*, *Bunostomum phlebotomum*, *Capillaria* sp., *Haemonchus placei*, *Cooperia punctata*, and *Skrjabinagia odocoilei*. The two white-tailed deer contained four of the above species of parasites, and one other, *Ostertagia ostertagi*, not found in the fallow deer.

Based on a review of the literature, five new host records were found and are reported from fallow deer: *Bunostomum phlebotomum*, *Haemonchus placei*, *Cooperia punctata*, *Skrjabinagia odocoilei*, and *Setaria tundra*.

STUDIES ON THE PRODUCTION OF ANTIBODY AGAINST RATTLESNAKE (*CROTALUS ADAMANTEUS*) VENOM IN RABBITS

Jennie L. Cabler
Florence State University
Florence, Alabama

Each of two rabbits received seven injections of venom from *Crotalus adamanteus*, Eastern diamondback rattlesnake; one rabbit was injected intradermally and one intramuscularly. Sera were extracted from each rabbit at intervals based on each injection of venom. These sera were subjected to gel-diffusion tests, which demonstrated no precipitin-type antibodies. Hemolysin-neutralization tests were also performed. The tests demonstrated that the sera provided protection for red blood cells against the venom; however, there was no significant difference between the protection provided by normal serum and the serum obtained after injections of venom. Horse serum also provides this protection as determined by the same type test.

Abstracts

SEPARATION OF CHLOROPLASTS IN DENSITY GRADIENTS

Brenda R. Chafin, Martha K. Dagg, Mitch Griffith*,
and George B. Cline

Department of Biology, University of Alabama, Birmingham
and

*Spinco Division, Beckman Instruments
Palo Alto, California

Chloroplasts can be rapidly and efficiently isolated in discontinuous density gradients in zonal rotors. Studies with homogenates of spinach leaves show that the shape of the gradient is important. When gradients are either linear with rotor volume or linear with rotor radius there is only one chloroplast zone isolated with a banding density in sucrose of 40% (w/w). There is no significant difference in the shape of the zone when the gradient is either center unloaded or edge unloaded. When discontinuous gradients are made with a gradient pump, the single zone of chloroplasts is fractionated into two to three additional small zones. When the gradients are carefully made by manual means for highest resolution separations, four distinct and separate chloroplast zones are recovered. These zones of material are banded isopycnicly at 38%, 40%, 43%, and 45% sucrose. A separate zone of material is banded at about 55% and is assumed to be peroxisomes. Another unidentified zone is recovered at 31%. Light microscopy does not show any significant morphological distinctions among the four chloroplast zones. Possible reasons for such differences in banding density include: a) age of chloroplasts, b) content of starch, c) relative amounts of nucleic acids and/or d) permeability differences in sucrose. Spectral analysis of each class from 750 nm to 220 nm does not reveal significant differences. Further analysis is in progress.

DISTRIBUTION ANALYSIS OF WATER-BORNE PARTICULATES BY ZONAL CENTRIFUGATION

George B. Cline, Brenda Chafin, and Martha K. Dagg
Department of Biology
University of Alabama, Birmingham

Continuous sample flow zonal centrifuge systems are highly useful for the rapid isolation and partial characterization of the range of particulates which make up the biomass in natural waters. The Model K-II zonal rotor was used without a gradient in these studies to collect and concentrate particulates which had sedimentation coefficients ranging from 400 to about 10,000,000 S. Biomass components which have sizes of 400 S or larger include many viruses, all bacteria, phytoplankton and zooplankton. The K-II-concentrated particulates were then further fractionated on sucrose density gradients in the B-XIV batch-type zonal rotor. Particulates with density greater than 65% sucrose were sedimented through the gradient and recovered from the rotor wall. Coliform bacteria recovery by these methods from water collected from Village Creek, Jefferson County, Alabama, showed a starting titer of 16,800 per ml. The ratio of lactose fermenters to non-fermenters was approximately 2:3. A small number of both gram positive bacteria and

Shigella were present but qualitative tests for Salmonella were negative.

On the basis of total protein determinations, the starting sample contained 57 mg/ml. About 95% of this material (primarily plankton) was trapped by cheese cloth and 100 mesh dacron filter. The zonal rotor trapped about 82% of the total proteinaceous material which passed the dacron filter when the sample flow-through rate was 15 liters/hr and the rotor speed was 30,000 rpm. Flow-through rates and absorbance tracings of the density gradients can give a rapid and direct indication of the density and amount of different size classes of particulates. This technique is being evaluated as a routine method of determining the distribution of biomass in fresh water. (This research was supported by a research grant from Electro-Nucleonics, Inc., Fairfield, N.J.)

CULTIVATED EVERGREEN PLANTS OF NORTHEAST ALABAMA

Thomas Cochis and Kenneth Landers
Jacksonville State University
Jacksonville, Alabama

The value of cultivated evergreen species of plants in the landscape of homes is emphasized by the viewing of poor and well landscaped homes of the area. Well landscaped homes, apartment buildings and trailer parks add to the total value of a community. Part of our effort in improving our environment should be the use of cultivated evergreen ornamental plants.

By viewing 35 species of evergreen ornamentals of the area, presented on 2x2 slides, interested persons might have the knowledge of which plants do well in this part of Alabama. The check list of plants include the following species by common name: cherry laurel, big leaf ligustrum, California golden privet, firethorn, abelia, ornamental viburnum, bamboo, clethra, yaupon, round leaf holly, Burford holly, American holly, heavenly bamboo, Oregon grape, southern magnolia, euonymus, photinia, boxwood, Russian olive (silverleaf), sasanqua, shortleaf pine, Virginia pine, longleaf pine, loblolly pine, white pine, eastern redcedar, sprawling juniper, white cedar (arbor vitae), eastern hemlock, Colorado blue spruce, Norway spruce, China fir, Arizona cypress, and true fir.

COMPARATIVE MORPHOLOGICAL STUDY OF FIVE TRIBES OF CERCOPINAE (INSECTA: HOMOPTERA: CERCOPIDAE)

Danice Heartsill Costes
Troy State University
Troy, Alabama

Morphological characters and combinations of characters were found that were useful in comparative studies of certain higher categories of Cercopidae.

Five tribes of Cercopinae, namely Ischnorhinini Schmidt, Tomaspidini Lallemand, Cercopini Lallemand, Tiodini new tribe, and Monedphorini new tribe are defined and compared; their included genera are also compared based on their similarities and differences. In addition to the new tribes listed above, four new genera and seven new species are described.

Abstracts

The major emphasis of this study is on the male genitalia; 313 illustrations are presented.

EFFECT OF CROP ROTATION AND FERTILIZER TREATMENTS ON POPULATIONS OF FREE-LIVING SOIL NEMATODES

R. J. Collins and R. Rodriguez-Kabana
Department of Botany and Microbiology
Auburn University, Auburn, Alabama

Population levels of *Mononchus* sp., *Dorylaimus* sp., and saprophytic nematodes were studied in field plots under the 3-year rotation scheme: corn and winter wheat, soybeans and fallow, and cotton; some plots received a winter legume. For 10 continuous years, plots received essentially the same fertilizer treatments ranging from a complete formulation of lime, N, P, K, and minor elements to treatments deficient in one or more components. Plots were sampled at monthly or bimonthly intervals for a 12-month period. Populations of *Mononchus* sp. were highest during cool months (December through April) when the soil was fallow or under a winter legume cover, and lowest during the normal growing season. Populations failed to build up in the soil during winter wheat culture. Low nitrogen and lime content in the soil repressed populations of *Mononchus* sp. Saprophytes and *Dorylaimus* sp. populations were highest during warm months with population increases following increased plant growth and total nematode populations. Populations of *Dorylaimus* sp. were lowest under winter legume, and high during fallow and wheat culture. Saprophyte populations were low during winter months regardless of winter crop. Numbers of *Dorylaimus* sp. were lowest in soils that received no fertilizer; otherwise soil fertility levels had little effect on population. Soil with highest fertility levels supported highest saprophyte populations.

EVALUATION OF THE RK-II FLO-BAND ZONAL ROTOR

Martha K. Dagg and George B. Cline
Department of Biology
University of Alabama, Birmingham

The Model RK continuous-sample-flow zonal centrifuge has been designed for the large scale isolation of cells, subcellular particulates, and viruses on a research and production basis. The RK-II rotor is the latest in a series of reorienting rotors for the RK machine and has now been evaluated for sucrose density gradient stability and recovery under a variety of conditions. Exits at both ends of the rotor permit gradient loading from the bottom and gradient collection from either the bottom or the top. No differences in gradient shape were found when comparing top-unloaded gradients from bottom-unloaded gradients.

Zone spread in discontinuous gradients was determined by the widening of the zone of bovine serum albumin on a) loading and unloading without gradient reorientation and b) after one reorientation in sucrose gradients at ambient temperatures. Recovered zone width at half peak height increases by about 20% after one reorientation.

Gradient shape varies with a) the rate of acceleration of the rotor from rest, b) the time at speed, c) the temperature of the gradient and d) the time duration and volume of sample passed over the centripetal surface of the gradient. Rapid acceleration (no ramping) of dense gradients creates little mixing. Gradients decay rapidly by diffusion at ambient temperatures, and this decay is enhanced by reorientations. The data suggest that the RK-II rotor in the present Model RK zonal centrifuge will be an effective isolating tool for volumes of sample of up to about 100 liters or 4 hours, whichever comes sooner. (This research was supported by a research grant from Electro-Nucleonics, Inc., Fairfield, N.J.)

NOTES ON NITROGEN EXCRETION IN THE SCORPION *VEJOVIS CAROLINIANUS* AND THE SPIDER *CTENUS HIBERNALIS*

Roderick Farb, Cole Benton, and B. G. Moore
Department of Biology
University of Alabama, University

The presence and relative abundance of purines in the excreta of representatives from two orders of arachnids were studied. The scorpion *Vejovis carolinianus* and the spider *Ctenus hibernalis*, collected from Tuscaloosa County, were used in this study.

Chromatographic analysis of the excreta was performed on a Dowex 50 column equipped with a U.V. monitor. The elution profiles of the excreta from both species were identical and showed the presence of three peaks. The three peaks have been identified from spectral data and paper chromatography as guanine, uric acid, and xanthine, with guanine as the major purine excretory product in both species.

Quantitative estimates of the relative amounts of each purine present demonstrate that guanine is present to about the same extent in both *Vejovis* and *Ctenus* (around 78% of purines excreted), while the proportion of uric acid is greater in the excreta of the spider (15%: 6%). Xanthine comprised the smallest percentage of the purines found in the excreta and was present in both species to the extent of 4-5%.

SOME PROPERTIES OF ALCOHOL DEHYDROGENASE FROM *EUGLENA GRACILIS*

Roderick Farb, J. L. Mego, and B. G. Moore
Department of Biology
University of Alabama, University

The oxidation of a variety of alcohols and the NAD-dependent alcohol dehydrogenase (alcohol: NAD oxidoreductase, EC 1.1.1.1) activity were studied in the alga *Euglena gracilis* strain Z, grown in a variety of heterotrophic media. Both green cells and a permanently chloroplast free mutant were investigated.

A crude enzyme preparation obtained from the supernatant fraction (whole cell supernatant) of ruptured cells centrifuged at 40,000 x g was used in this preliminary study.

Cells grown in media containing acetate as the sole carbon source had the same alcohol dehydrogenase activity as cells grown in media con-

Abstracts

taining ethanol as the sole carbon source. The alcohol dehydrogenase from these cells was solely NAD-dependent, most active with isopropanol as substrate, and possessed maximal activity at a pH of 8.0 for all alcohol substrates tested.

A variety of inhibitors were tested using ethanol and isopropanol as substrates. Mercaptoethanol inhibited 80% of the activity with isopropanol as substrate compared to only 14% inhibition with ethanol. PCMB exerted greater inhibitory effect with ethanol (61%) than with isopropanol (40%). Zinc reversed the mercaptoethanol inhibition and appeared to have a greater reversal effect when ethanol was used as substrate. Zinc, alone, inhibited activity with isopropanol and greatly stimulated activity with ethanol. Iodoacetamide had no effect at a concentration of 6.6 μ m with either substance.

A PRELIMINARY INVESTIGATION OF POLLUTION AND ITS DISTRIBUTION IN MOBILE BAY

Roderick Farb and B. G. Moore
Department of Biology
University of Alabama, University

Quantitative laboratory analyses were made for the presence and relative levels of nitrate, nitrite, phosphate, dissolved oxygen, and various pesticides from water and sediment samples taken from a number of selected locations in Mobile Bay.

The dissolved oxygen and nitrate concentrations were highest in the upper regions of the bay while phosphate and nitrite concentrations were highest in the lower regions of the bay.

Laboratory analyses of sediment samples for aldrin, BHC-lindane, chlordane, DDD, DDE, DDT (pp'), dieldrin, endrin, heptachlor, and methoxychlor demonstrated that DDT (pp') and its metabolites DDD and DDE were present in the highest concentrations (0.001-1.1 ppm) and were found with the greatest frequency in all of the samples investigated. DDT (pp'), DDD, and DDE were found in all sediment samples analyzed.

Aldrin, BHC-lindane, chlordane, dieldrin, endrin, heptachlor, and methoxychlor, although not detected in all samples, were found in the 0.001 ppm concentration range in bay sediment samples in which they were detected.

Aldrin was found at concentrations of 0.011 ppm at a sampling on a river that feeds into the upper reaches of the bay. The concentrations of all pesticides detected were the highest at this sampling station, and their concentrations appear to diminish from the upper to the lower portions of the bay.

CHARACTERISTICS OF ARSENITE AS A TERATOGEN

Ronald D. Hood
Department of Biology
University of Alabama, University

Sodium arsenite was administered to albino Swiss-Webster mice intraperitoneally as an aqueous solution. Injections of 0.27-0.42

ml of a 1 mg/ml aqueous solution were used to provide a treatment dose of 10 or 12 mg/kg body weight on one of days 7-12 of gestation. At least 5 females were treated for each day and dose level combination. Controls were treated with an equivalent volume of distilled water. Females were sacrificed on day 18 of pregnancy and their reproductive tracts and fetuses examined. Treatment with arsenite resulted in a significant increase in fetal deaths as indicated by resorptions at all days and treatment levels. Both treatment levels resulted in some maternal deaths. The 12 mg/kg dose tended to give higher rates of fetal deaths than did the lowest dose level on days 8, 9 and 11. A number of fetal malformations were noted, particularly in fetuses treated on days 9 and 10. These included agnathia, anophthalmia, displaced pinna, exencephaly, micromelia and ectopic kidneys. Skeletal defects were also noted, particularly skull defects associated with exencephaly and micrognathia, and fusion and forking of the ribs. No such anomalies were noted in control fetuses. The incidences of fetal malformations associated with arsenite treatment tended to be lower and of resorptions higher than those associated with a 45 mg/kg dose of sodium arsenate. Since arsenate is thought to be toxic largely due to *in vivo* conversion to arsenite, such differences could be due to the shorter term, more acute exposure to the toxin associated with use of arsenite as the treatment agent.

SODIUM ARSENATE INDUCED TERATOGENESIS IN MICE

Ronald D. Hood and Sally L. Bishop
Department of Biology
University of Alabama, University

Random-bred albino Swiss-Webster mice were treated with sodium arsenate on one of days 6-12 of gestation. Treatment was by single intraperitoneal injections of 0.45 to 0.66 ml of a 4 mg/ml aqueous solution of the hydrate ($\text{Na}_2\text{HAsO}_4 \cdot 7\text{H}_2\text{O}$), corresponding to a dose of 45 mg arsenate/kg of body weight. Controls were treated with an equivalent volume of distilled water. Arsenate treatment resulted in an increase in fetal resorptions, as a consequence of early fetal deaths, particularly in litters from females treated on days 11 and 12. Fetuses were removed from each uterus, examined, and weighed on gestation day 18. Treatment significantly lowered fetal weights compared with control weights for all treatment days except day 12. Arsenate treatment resulted in a treatment-day dependent range of fetal malformations. Exencephaly, micrognathia, protruding tongue, exophthalmos, naked eye, umbilical hernia, shortened tail and various rib, vertebral and skull defects were among the most frequently observed anomalies.

CHARACTERIZATION OF THE PROTEIN FROM GAS-VACUOLE MEMBRANES OF THE BLUE-GREEN ALGA, *MICROCYSTIS AERUGINOSA*

Daniel D. Jones
Department of Biology
University of Alabama, Birmingham

The gas vacuoles of the blue-green alga, *Microcystis aeruginosa*, ap-

Abstracts

pear to have limiting membranes composed entirely of a single protein. The lipids and numerous protein species usually expected in biological membranes are not found in the gas-vacuole membranes. The purified protein of the membranes consists of 52% non-polar, 18% acidic and 10% basic amino acids, from which imino and sulfur amino acids are absent. End-group analyses, tryptic digest, and gel electrophoresis at acidic pH indicate that the protein is a single species of about 14,500 MW. These chemical data are supported by a structural analysis which shows the membrane to be composed of a single layer of subunits $2.8 \times 4.2 \times 3$ nm. Appreciable solubilization of the membranous protein occurred only in the presence of strongly protic solvents as formic acid. Infrared spectroscopy shows that the protein of the membrane has substantial amounts of both the alpha-helix or random coil conformation and of the beta conformation. (This work was supported in part under Contract No. AT(11-1)-1338 with the U.S. Atomic Energy Commission.)

FOREST ECOLOGY OF NORTHWEST ALABAMA

Kenneth Landers and Thomas Cochis
Jacksonville State University
Jacksonville, Alabama

Although much of Northeast Alabama still consists of woodlands, the forest ecology of the area is changing rapidly. Lumbering operations and the clearing of trees for farms, homesites, highways, industrial sites, shopping centers, and urban areas are continuing to decrease the extent of the forests of the region. Huge tracts of hardwood timberlands are being converted into pinelands by chemical and mechanical methods. Strip mining and channelization of streams are drastically changing the forest ecology. Large impoundments on the Coosa River and the Tennessee River also cover much of the original woodlands. Backwater from a new dam on the Tallapoosa River will soon cover other large areas.

Due to commercial management and planting, some native gymnosperm species are growing in increasing numbers. Loblolly, shortleaf, and Virginia pines are common, and longleaf pine occurs frequently along the ridges from Etowah County to the south. Eastern redcedar is very common in the limestone areas. Eastern hemlock is often planted as an ornamental, but has a very limited distribution as a native tree. Baldcypress trees are increasing in number around the large river impoundments.

The best quality angiosperm trees of the stream margins and rich woods, such as the ashes, beech, black cherry, blackgum, cottonwood, elms, hickories, maples, oaks, red mulberry, river birch, sugarberry, sweetgum, and yellow poplar, have been harvested. In many locations these woodlands have been invaded by weedy trees such as the alder, hornbeam, hophornbeam, and willow, as well as thickets of shrubs, weedy herbaceous plants, and vines.

Stands of black walnut, basswood, persimmon, upland elms, hickories, and oaks have also been reduced in size and quality. Trees of less commercial value and of more academic and aesthetic interest, such as the American holly, bladdernut, buckeyes, bumelia, Carolina buckthorn, Carolina silverbell, catalpa, crabapple, chestnut, chinkapin, dogwoods, fringetree, hawthorn, honeylocust, magnolias, osage-orange, pawpaw, plums,

redbud, serviceberry, sourwood, and witchhazel are also cleared away in large numbers.

Sassafras and sumacs occur frequently along fencerows, roadsides, and in open woods. Although large trees are seldom seen, thickets of black locust grow along the roadsides in extreme Northeast Alabama. Sparkleberry sometimes becomes weedy in open-upland woods and is common in moist soils.

Common introduced angiosperm trees of the area include chinaberry, tree of heaven, silktree, paper mulberry, paulownia, white poplar, and to a limited extent, white mulberry. These trees are especially weedy in urban areas and in some cases are becoming weedy along rural highways and open woods.

Except for a degree of protection offered in parks, nothing has been done to assure the survival of certain rare and restricted native angiosperm trees for the area. This group of trees includes shingle oak, bluejack oak, dwarf post oak, sweet birch, smoketree, water tupelo, sweetbay, blue ash, butternut, and bigleaf magnolia. Since little control is expected to be directed toward privately owned forest land, it is quite important to consider greater regulation of public parks in order to retain examples of the variety of native species occurring in the region.

HETEROLYSOSOME FORMATION AND FUNCTION IN SOME ANURANS

John L. Mego

Department of Biology

University of Alabama, University

The complex series of events which occur when a foreign macromolecule or particulate material is taken up by a cell has been studied largely by electron microscopy or histochemistry. It is also possible to study this process by biochemical methods. Extensive studies have been performed on the uptake and degradation of radiiodinated serum albumin in mice, but the techniques used have not been extended to other animals. In the present study the uptake and degradation of radioiodinated bovine serum albumin, which was treated with formaldehyde at pH 10, was studied in three species of anurans: *Bufo americanus*, *Rana pipiens*, and *Xenopus laevis*.

Initial studies were performed with *Bufo* and *Rana*. The animals were anesthetized with ether, the chest cavity was opened, and the labelled albumin was injected directly into the heart. In these animals, large amounts of labelled protein were taken up by the liver and kidneys 2 hr after injection. In the mouse, maximum uptake occurs about 30 min after injection. The formation of heterolysosomes, as evidenced by the capacity of particulate fractions centrifuged from liver and kidney homogenized to degrade associated labelled protein, also did not occur in *Bufo* or *Rana* until 2 hr after injection. When *Xenopus* was anesthetized with ether and the same procedure followed, relatively little uptake of the labelled protein occurred in the liver and kidneys, and no degradation of the protein occurred in particulate fractions from the liver. If the animal was pithed before injection of labelled protein, the same results were obtained. Pithing also inhibited uptake and degradation of the protein in liver and kidneys of *Rana*. It was noted that pithing caused the

Abstracts

lungs of both *Rana* and *Xenopus* to collapse. Furthermore, unlike *Rana* or *Bufo*, *Xenopus* did not recover from the effects of ether during the 2-hr period after injection of labelled protein. An experiment was then performed in which the lungs of a pithed *Xenopus* were aerated during the 2-hr interval after injection. There was increased uptake of protein in the kidneys and liver of this animal, and degradation of particle-associated protein occurred suggesting that heterolysosome formation had taken place under these conditions. The results indicate that oxygenation of the blood is required for uptake of labelled protein and for heterolysosome formation in the liver.

Degradation of particle-associated labelled protein in fractions from the liver of *Bufo* and *Rana* was inhibited by iodoacetamide and by osmotic shock. The process also required the presence of mercaptoethanol in the medium. These results suggest that cathepsins B and C were involved in the proteolysis. The uptake and degradation of foreign proteins in the liver and kidneys of anurans, therefore, occurs by the same mechanisms as those previously established in mice. The process differs from mammals by requiring a longer period for heterolysosome formation to occur. This may be due to the lower body temperatures of anurans.

Anurans may be better experimental animals for the study of uptake of materials from the blood stream and for heterolysosome formation. Since the frog does not have a diaphragm, the chest cavity may be opened and the material can be injected directly into the heart. Furthermore, long after brain centers or other organs are destroyed, the heart continues to beat and the circulation is maintained, and the effects of metabolic inhibitors and other drugs on the process of heterolysosome formation may be studied. Since frogs are poikilothermic, the effects of temperature on uptake into cells and heterolysosome formation may also be studied.

ISOLATION OF A NEW METABOLITE FROM THE CULTURE MEDIUM OF *ASPERGILLUS OCHRACEUS*

Jack H. Moore, Norman D. Davis, and Urban L. Diener
Department of Botany and Microbiology
Auburn University, Auburn, Alabama

Strains of *Aspergillus ochraceus* are common contaminants of soils, decaying vegetation, and stored grain. Known metabolites of this fungus include ochratoxin A and mellein.

A new metabolite has been isolated from the synthetic culture medium of an ochratoxin-producing isolate of *A. ochraceus*. This chemical apparently is structurally similar to mellein and the dihydro-isocoumarin moiety of ochratoxin A and possibly is a biosynthetic precursor of ochratoxin A.

GLYCOGENOLYTIC EFFECT OF SEROTONIN IN THE INTACT ANIMAL

Alice Hardin Morgan
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

An investigation of the effect of endogenous serotonin, or 5-hydroxy-

tryptamine (5-HT), on blood glucose and liver glycogen was undertaken to clarify the role of endogenous serotonin in carbohydrate metabolism. The reserpine compound, Serpasil^R, was used to release serotonin from its storage sites, and nialamide, a monoamine oxidase inhibitor, was utilized to prevent oxidative destruction of the amine by monoamine oxidase. 5-hydroxytryptophan (5-HTP), the precursor of 5-HT, was administered to build up the existing level of 5-HT in the intact animal. Blood glucose and hepatic glycogen were measured to determine how these parameters were affected by the increased serotonin level brought about by pharmacological manipulation.

When reserpine was administered to the rats no increase in blood glucose was observed, indicating that Serpasil^R was not hyperglycemic at the dose used. Treatment with nialamide followed by reserpine brought about a decrease in hepatic glycogen and an initial hyperglycemia. Liver glycogen dropped sharply when the animals were given nialamide followed by 5-HTP, but blood glucose was not significantly different from control values. Pretreatment with reserpine, followed by injections of nialamide and 5-HTP, also resulted in a precipitous drop of hepatic glycogen and an increase in blood glucose.

THE AUTORADIOGRAPHIC ANALYSIS OF THE LOCALIZATION AND
MOBILIZATION OF (¹⁴C)-5-HYDROXYTRYPTAMINE AS
RELATED TO INTESTINAL CONTRACTILITY

Christopher W. Old
Auburn University, Auburn, Alabama

In order to more fully clarify the role of serotonin in the modulation of intestinal motility, we designed a study consisting of two phases utilizing 110 animals. Phase I was concerned with the measurement of intestinal motility after the I.V. administration of the serotonin precursor, 5-hydroxytryptophan.

Phase II employed autoradiography to localize ¹⁴C-labeled 5-hydroxytryptamine in the duodenum. Twenty female rats were pretreated with Serpasil, Marplan, and (¹⁴C)-5-hydroxytryptophan. The animals were sacrificed at various time intervals, and autoradiograms were made of the duodenum.

The results of Phase I of this investigation established a peak in duodenal contractility 4 hr after the serotonin precursor injection. This peak in intestinal activity can be correlated with Phase II maximum (¹⁴C)-serotonin labeling in the myenteric plexus at the 4-hr interval also. It is reasonable to conclude from these data that serotonin is possibly a neuromediating amine in the myenteric plexus and that it has an excitatory role in this region.

HEMATOLOGICAL STUDIES OF THE ROSEFIN SHINER, *NOTROPIS ARDENS*

Linda Quattrochi
Florence State University
Florence, Alabama

Blood from the Rosefin Shiner, *Notropis ardens*, was removed from

Abstracts

the heart and 1-3 blood smears were prepared for each of 20 specimens. Erythrocytes, thrombocytes, and leukocytes were described. Eosinophils, monocytes, neutrophils, lymphocytes, and a number of other blood cells were observed and described. Differential counts were made from the smears. There was little variation in the number of monocytes, neutrophils, and small lymphocytes. The average percentages for these cells are as follows: neutrophils, 3.1 (0.5-8.0)%; small lymphocytes, 32.5 (21.0-68.5)%; monocytes, 5.5 (0.5-17.0)%. However, there was considerable variation among the other blood cells.

ENZYMATIC ACTIVITY OF SOIL IN RELATION TO SEASON AND CULTURAL PRACTICE: AMYLASE

R. Rodriguez-Kabana, George L. Benson, and E. A. Curl
Department of Botany and Microbiology
Auburn University, Auburn, Alabama

Effect of fertilizer treatment and cultural practices on amylase activity (AMA) in soil of plots planted to winter wheat and soybeans was studied for a 12-month period. Treatments varied from complete fertilization (N, P, K, lime, minor elements) to those deficient in one or more nutritional components. Each plot had received essentially the same treatment continuously for at least 10 years. Soil AMA declined sharply in all plots during the spring when winter wheat was maturing. Growth of soybeans during the summer resulted in a very rapid increase in AMA, which was maximal in August at early blooming time. Differences in AMA between plots were generally related to the yield of the plots; however, this was dependent on sampling time. Quantitative alignment of activity in the plots paralleled yield in March, but growth of soybeans in the summer eliminated some of the deficiencies in AMA between plots which existed in the spring. Deficiency of any major nutritional element or of lime caused marked reduction in activity; the extent of this decline depended on the particular element omitted.

ENZYMATIC ACTIVITY OF SOIL IN RELATION TO SEASON AND CULTURAL PRACTICE: ARYL PHOSPHOMONOESTERASE

R. Rodriguez-Kabana and Roger E. Smith
Department of Botany and Microbiology
Auburn University, Auburn, Alabama

A one-year study was conducted to determine the effect of fertilizer treatments and seasonal changes on aryl phosphomonoesterase activity (APA) in soil from plots planted to winter wheat followed by soybean as the major crop. Ten fertilizer combinations studied ranged from a complete formulation (N, P, K, lime, minor elements) to treatments deficient in one or more components. Each plot received essentially the same treatment continuously for 10 years. Very little change in APA occurred between March and April when wheat was beginning rapid spring growth; however, activity increased almost constantly thereafter, including the period after June and subsequent plantings of soybean. Generally, all plots reached maximal APA in August at early blooming time for soybean. With

some exceptions, plots that had received major elements of fertilization plus a winter legume had the greatest amount of activity; those deficient in major elements showed the least amount of APA. Omission of P in the fertilizer scheme resulted in significantly higher APA. Also, deficiency of commercial N in the presence of winter legume resulted in a considerable decline in enzymatic activity; this decline was further evident in plots where the winter legume was omitted. Absence of K did not result in as drastic a drop in activity as did the omission of N. Generally, the degree of seasonal change in APA was greater in soil of plots subjected to the more complete fertilization programs.

FRACTIONATION AND ANALYSIS STUDIES OF COMPONENTS OF THE NUCLEAR POLYHEDROSIS VIRUS OF THE COTTON BOLLWORM

Elaine M. Ryel and George B. Cline
Department of Biology
University of Alabama, Birmingham

Nuclear polyhedral inclusion bodies (NPIB's) and their structural components can be efficiently isolated and purified in high resolution discontinuous sucrose density gradients in the B-XIV zonal centrifuge rotor. Using this system, the isopycnic banding density of purified NPIB's of *Heliothis zea* is 1.257 (55.5% w/w sucrose). After the purified NPIB's are disrupted by weak alkali, their components can be fractionated into three distinct particle zones. These zones represent in increasing density: 1) the matrix protein, 2) the virions and 3) the outer coats of the NPIB's. The outer coats have been proposed by several investigators to be artifacts of electron microscopy. These coats have been zonally isolated here for the first time as distinct particles. Their separation in this manner permits their further characterization and analysis. Comparison between coat and matrix protein is now being made using gel electrophoresis. (This research was supported by a research grant from Electro-Nucleonics, Inc., Fairfield, N. J.)

ISOLATION OF COLLAGEN FIBRILS FROM DISEASED HUMAN PERIODONTIUM BY ZONAL CENTRIFUGATION

Richard B. Ryel and George B. Cline
Department of Biology
University of Alabama, Birmingham

Integrated techniques of zonal centrifugation and electron microscopy were used for the purification and morphological characterization of collagen fibrils from diseased periodontium. Gingival tissue taken from chronic periodontitis patients was immediately fixed in buffered 2% glutaraldehyde. The fixed tissue was homogenized in a Waring blender and filtered through cheese cloth. The filtrate was layered over 10% sucrose and centrifuged 5.2×10^4 g-min. The supernatant was used as the starting sample. A discontinuous sucrose gradient was stacked into a B-XIV zonal rotor followed by the starting sample and centrifuged 30,000 rpm for 5 hr. Fractions containing the banding zones were chosen, pelleted and embedded for thin sectioning. Electron microscopy revealed

Abstracts

a highly purified zone of collagen fibrils banding in sucrose at a density of 1.27. The diameter of the collagen fibrils varied from 400 Å to 800 Å representing a substantial size range deviation from the normally consistent 500 Å seen in non-diseased gingival tissue. It is suggested that the individual fibrils isolated in this study represent components of the indifferent collagen plexus. This investigation has provided an effective method for the procurement of highly purified preparations of collagen fibrils for related studies concerning collagen diseases.

EFFECT OF TIME, TEMPERATURE, pH, AND AERATION ON OCHRATOXIN A PRODUCTION BY *ASPERGILLUS OCHRACEUS*

Gerald A. Sansing, Norman D. Davis, and Urban L. Diener
Department of Botany and Microbiology
Auburn University, Auburn, Alabama

Effect of time, temperature, pH, and aeration on production of ochratoxin A and mycelium by *Aspergillus ochraceus* Wilh. was determined using a semisynthetic medium containing 4% sucrose and 2% yeast extract. Maximal ochratoxin A (24 mg/l) was produced in 12 days at 25 C when the fungus was cultured in 125-ml flasks; 82% was produced in the first 8 days. Results of the medium volume-to-flask volume (aeration) study revealed that maximal ochratoxin A production (320 mg/l) was obtained in 125-ml flasks containing 25 ml of medium incubated at 25 C for 8 days. Ochratoxin A production corresponded to an increase in medium pH and to mycelial production with time. Further incubation, after maximal production was attained, resulted in a decrease in toxin concentration, mycelial dry weight, and medium pH. Ochratoxin A was not produced in shake cultures incubated for 8 days at 25 C. Replacement culture techniques were found to be impractical for the production of large quantities of the toxin.

A STUDY OF COMBINED TEMPERATURE AND SALINITY LEVELS IN THE HERMIT CRAB, *PAGURUS LONGICARPUS* SAY

Harvey A. Stackman
University of Alabama, University

The Hermit Crab, *Pagurus longicarpus* Say, is a widespread estuarine organism of the Atlantic and Gulf coastal region. A study was undertaken to determine the effects of prior thermal history on the thermal resistance of this organism at salinity levels ranging from 10‰ to 40‰ at elevated temperatures.

Results show that elevated temperatures are tolerated better at salinities higher than those found in the habitat of the experimental animals up to a level of 35‰. Organisms acclimated to higher temperatures tolerate increased temperatures better than those acclimated to lower temperatures at all salinities. A temperature of 41 C appeared to be the upper limit for this organism taken from the eastern portion of Mississippi Sound.

IRON BACTERIA AND ALABAMA WATER SUPPLIES

J. D. Stinnett, H. A. Mannich, and Margaret Green
University of Alabama, University

The Alabama Geological Survey has found iron encrustations in and on ground water delivery systems throughout the state of Alabama. In an effort to determine if these iron encrustations are the result of iron bacteria our laboratory has identified *Gallionella* microscopically in nearly all natural surface waters examined, though an experimental well field has failed to yield iron bacteria. *Gallionella* has been cultivated successfully in our laboratory in mixed culture, but continual transfer in enrichment media has resulted in death of the organisms. Attempts to obtain pure cultures by various methods have also proven unsuccessful. Preliminary electron microscope studies of *Gallionella* reveal structures supporting the reports of Vatter and Wolfe.

A QUANTITATIVE AND EPIDEMIOLOGICAL SURVEY OF PARASITES IN FIRST
GRADE CHILDREN IN DALE COUNTY, ALABAMA

Roger LaDon Stork and Carl F. Dixon
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

Research was conducted to determine the incidence and intensity of intestinal helminthiasis and the incidence of intestinal protozoan parasites among the first grade children of Dale County, Alabama, and to measure any changes in the parasite incidence and burden which occurred in the population. During the year 1970, fecal samples were obtained from 55 children.

On the basis of identification of characteristic ova present in the fecal samples, three species of intestinal parasites were found in the population: *Ascaris lumbricoides*, *Necator americanus*, and *Enterobius vermicularis*. Only *A. lumbricoides* and *N. americanus* are discussed in this paper.

The first graders studied were divided into urban and rural groups, by race and sex. The county was divided into four sections, and a representative number of samples was taken from each area.

Data obtained during this study were compared to surveys made in Dale County in 1911 by the Rockefeller Institute, and to surveys made by the Alabama Department of Public Health in 1954. The incidence and worm burdens have decreased in each of the successive surveys.

SOME ASPECTS OF THE IMMUNOLOGY OF A STRONGYLOID INFECTION
IN THE DOMESTIC RABBIT

Jeanne J. Stuart and Carl F. Dixon
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

In a preliminary study of the immunological system of *Trichostrongylus affinis* in the domestic rabbit, the patterns of cultivation, infec-

Abstracts

tion, and maturation were determined. The life cycle of *T. affinis* was outlined. Eggs hatched in fecal cultures within 10 hr at room temperature. The resulting L₁ larvae molted twice to the L₃ stage by day 7. Experimental rabbits, inoculated orally with these infective larvae, showed weight loss and diarrhea which increased to the 12th day; this coincided with the peak of patency of the worms. Egg per gram counts did not correlate positively with actual worm burdens, probably due to crowding and immune responses of the hosts. Packed cell volumes appeared to be increased in parasitized rabbits, as compared to those of non-infected controls. Plasma protein profiles, determined electrophoretically, showed slight elevations in the beta-globulin fractions in parasitized rabbits, as compared to those of the controls.

SURVEY ON DISEASES OF ORNAMENTALS IN THE MOBILE AREA

F. J. Subirats and R. L. Self
Ornamental Horticulture Field Station
Auburn University, Mobile, Alabama

A 4-month survey of 25 species of ornamental plants revealed a number of physiogenic and pathogenic induced diseases. Included was the collection, examination, and identification of diseased plant specimens found in nurseries, and in home and public gardens.

A mite caused bud drop and "bull heading" of camellias, and *Pestalotia* sp. (fungus) induced petal blight of camellias; these disorders have not been previously described.

STRONTIUM SUBSTITUTION FOR CALCIUM AND ALGAL CELL SIZE

Jerry P. Thomas, Samuel W. Moss, and Joseph C. O'Kelley
Department of Biology
University of Alabama, University

Mature cells of some algal species, which will grow in a medium with Sr substituted for Ca, are larger and more highly vacuolated than control cells in Ca. In logarithmic phase cultures average size of cells in Sr-replacement medium was greater than that for control cells in Ca. The water content of Sr-replacement cells appeared to be greater than that of control cells. Mechanisms whereby water content and cell size differences may become established are discussed.

ADRENAL STRESS DURING ESTRUS, PREGNANCY, PARTURITION, AND LACTATION IN WHITE RATS

Margaret Till
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

The objective of this study was to determine the relative activity of the anterior pituitary-adrenal axis during the estrus cycle, pregnancy, parturition, and lactation in white rats. The level of adrenocorticotro-

phic hormone (ACTH) secretion was measured by ascorbic acid depletion of the adrenal glands. In phase I, assays were made during proestrus, proestrus-estrus, estrus, metestrus, and diestrus. Phase II involved assaying on days 5, 10, 15, and 20 of pregnancy. In phase III ascorbic acid was measured within 2 hr after parturition and on days 5, 10, and 20 of lactation.

The lowest ascorbic acid level in the estrus cycle was observed during estrus indicating greater adrenocortical activity at this time. The mean ascorbic acid level during pregnancy was found to be lower than in the cycling rat. Parturition exhibited the highest level of adrenocortical activity found in this study. During lactation ascorbic acid levels were lower than in cyclic rats.

A STUDY OF DEVELOPMENT AND NUCLEIC ACID SYNTHESIS DURING THE LIFE CYCLE OF *VOLVOX AUREUS* M5

Robert G. Tucker and William H. Darden, Jr.
University of Alabama, University

This paper reports the normal course of RNA and DNA synthesis during the vegetative life cycle of *Volvox aureus* M5 and discusses developmental effects observed after inhibition of synthesis of these macromolecules by actinomycin D and mitomycin C. Isotopically labeled nucleic acids were extracted from synchronous *Volvox* colonies by a phenol-sodium dodecyl sulfate procedure. Quantitative determinations were made by liquid scintillation counting following specific digestion of the extracted nucleic acids with RNase or DNase. Total enzymatically digestible RNA and DNA were determined at 12-hr intervals during the complete vegetative life cycle (approximately 65 hr with the growth conditions used). Maximum amounts of both RNA and DNA were found in the 36-48 hr developmental stage. Mitomycin C at 45 µg/ml and actinomycin D at 4 µg/ml prevented subsequent development when administered at any of the developmental stages. These antibiotics were specific at the concentrations used. Actinomycin D inhibited RNA synthesis approximately 87% with negligible effect on DNA synthesis and mitomycin C inhibited DNA synthesis about 91% with no appreciable effect on RNA synthesis. The significance of these results relative to vegetative development in *Volvox* is discussed.

THE WINTER BIRDS OF WHEELER NATIONAL WILDLIFE REFUGE 1970-1971

George Williams, Jr.
Department of Biology
Athens College, Athens, Alabama

Wheeler National Wildlife Refuge is located on the Wheeler Reservoir of the Tennessee River in North Alabama. During the winter of 1970-1971 a weekly census was taken either by a 5-day ground count or by aerial estimate. The Christmas bird count was on January 2, 1971. Approximately 35,000 Canada Geese, 1500 Blue Geese, 150 Snow Geese, and 14 Blue-Snow hybrids were counted in January, representing an overall increase in

Abstracts

waterfowl as compared to counts made a year ago. There were about 36,000 mallards, 4,000 blacks, 5,000 baldpates, 2,500 pintails, 2,000 gadwalls, 500 green-winged teal, and 600 shovellers present. The diving ducks included redheads, ringnecks, scaups, common goldeneyes, buffleheads, ruddies, and hooded mergansers, but in small numbers. On the Christmas bird count a Swainson's and a Rough-legged hawk were seen by Tom Imhoff. Other species in the area during the count period included a horned grebe, a whistling swan, a ring-necked pheasant (Iranian race, introduced), and an immature Bald Eagle.

THE EFFECT OF RIVER DISCHARGE ON THE BIOTA OF THE MOBILE BAY ESTUARY

Louis G. Williams
Biology Department
University of Alabama, University

Diversity and standing crop decrease drastically for both the plankton and the periphyton during the annual spring discharge of the Mobile River into Mobile Bay and into the *Juncus* and *Spartina* marshes of the estuary. After turbidities from the river discharge subside, and salinities increase toward the summer, high standing crops accumulate from the salt marshes with large quantities of aggregates of bacteria and salt marsh detritus which become the principal food of the dominant copepod, *Acartia tonsa*; this is the principal food of most of the filter feeders of the Bay such as Menhaden fish and shrimp. Of all the phyto- and zooplankton and periphyton, diversity is lowest in upper Mobile Bay and highest in Mississippi Sound near Petit Bois Island. The low diversity of this biota in upper Mobile Bay appears to be associated with industrial pollution arriving from river discharge into the upper bay.

CHEMISTRY

DENSITY MATRIX TECHNIQUE APPLIED TO THE CALCULATION OF TEMPERATURE DEPENDENT ESR SPLITTINGS

Carolyn Bogan and Lowell D. Kispert
Department of Chemistry
University of Alabama, University

Density matrix descriptions of motional effects in magnetic systems provide a nearly exact treatment of a spin system subject to driving terms or motional effects. With a transformation into Liouville space, magnetic resonance problems can be solved by density matrix techniques.

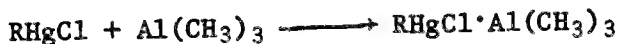
The electron spin resonance (ESR) spectra of $\cdot\text{CF}_2\text{CONH}_2$ shows a temperature dependence which is postulated to be caused by restricted internal rotation. Transformation of this system into Liouville space and solution of the equation of motion of the density matrix reproduces the spectrum at low temperature. The driving terms which represent the motional effects are not derivable from first principles. It is expected that a better formulation of these terms will reproduce the spectrum over a large temperature range and will provide insight into the

motions of the system. (Supported in part by the Atomic Energy Commission)

SYNTHESIS AND STRUCTURE OF THE ADDUCT OF CHLOROMERCURIFERROCENE
AND TRIMETHYLALUMINUM

W. J. Cook and J. L. Atwood
Department of Chemistry
University of Alabama, University

We have prepared a new class of organometallic compounds according to the general reaction



where $\text{R} = \text{CH}_3$, $\text{C}_5\text{H}_4\text{FeC}_5\text{H}_5$, $\text{C}_5\text{H}_4\text{FeC}_5\text{H}_4\text{HgCl}$. The method of synthesis consists of the sealed tube reaction of the chloromercury compound with an excess of trimethylaluminum. All substances are extremely air-sensitive and are handled only in a carefully purified nitrogen atmosphere. The adduct of chloromercuriferrocene and trimethylaluminum (melting pt. = $99-100^\circ\text{C}$) crystallizes from toluene in the orthorhombic crystal system. Preliminary single crystal X-ray data show the space group to be $\text{Pna}2_1$ or Pnma , and the unit cell parameters, $a = 8.97 \text{ \AA}$, $b = 11.74 \text{ \AA}$, and $c = 15.16 \text{ \AA}$. Three-dimensional X-ray data have been collected and structure solution is in progress. Infrared and nuclear magnetic resonance data are discussed.

SOFTWARE PROBLEMS AND THEIR SOLUTIONS ASSOCIATED WITH A
VARIAN DATA SYSTEM 620/1 COMPUTER INTERFACED TO AN
ESR SPECTROMETER

Sally Davenport and L. D. Kispert
Department of Chemistry
University of Alabama, University

A Varian data machine's 620/1 general purpose computer interfaced to an electron spin resonance spectrometer has been used to store, process, and display spectral data. The computer system includes a magnetic tape input/output unit for storage of programs and data, 8K word memory, 16 bit word and teletype input/output for data entry or display of computed results. The computer system comes equipped with several programs such as time averaging, spectrum simulation, spectrum plotting, CRT display from memory, and closed loop control. Currently, several new features are being added to enlarge the general usefulness of the programs. The problems associated with programming a small digital computer, where use of a conversational language such as Fortran is not possible, are quite different from that usually found with the conversational languages. The procedure required when using assembler language to output information to oscilloscopes and x-y recorders, and to input information from the electron spin resonance spectrometer, is discussed. (Supported in part by the Atomic Energy Commission and the National Science Foundation)

Abstracts

THE DETERMINATION OF PEAK POSITIONS AND LINE SHAPE FUNCTIONS FOR ESR DATA RECORDED ON MAGNETIC TAPE

Catherine Engelman and Lowell D. Kispert
Department of Chemistry
University of Alabama, University

Accumulated data from the electron spin resonance spectrometer can be recorded on magnetic tape through the Varian 620/1 computer. This allows the data to be processed on a larger machine which can handle programs requiring far more core space than the 8 K, which the Varian can provide. Specifically, the seven track Varian tapes are compatible with the IBM 360/50 system, and the discrete spectral data can be examined and adjusted in this larger system, then returned to the tape to be plotted at the Varian stage. Accurate measurements of the individual peak position requires spectral resolution of overlapping adjacent peaks. Experimental noise and peak bias can interfere with the determination of accurate peak position. Thus a least-square fitting procedure has been devised and proven to be successful in determining a line function and position for each recorded peak.

Other adjustments to the spectrum include correcting for any shift in the klystron frequency during the recording of the spectra and correcting the magnetic field due to inaccurate positioning of the nmr probe. Once the accurate line positions have been determined, the ESR a and g values are determined as a function of angle, temperature, or solvent and fed as input to the IBM 360/50 computer for analysis by computer programs resident on disk storage of the 360/50.

STRUCTURAL STUDIES OF ANIONIC ORGANOALUMINUM AZIDES

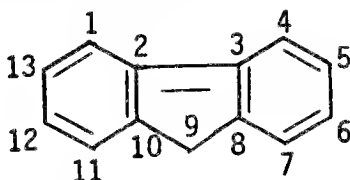
J. B. Goss, Jr. and J. L. Atwood
Department of Chemistry
University of Alabama, University

The interaction of alkali metal halides with aluminum alkyls has been known since 1960. This paper is concerned with the reaction of an alkali metal azide, a pseudohalide, with aluminum alkyls, in particular trimethylaluminum, to form 1:2 complex anions of the type $(\text{CH}_3)_3\text{Al}-\text{N}_3-\text{Al}(\text{CH}_3)_3$. Li, Na, K, Cs, and Rb complexes have been prepared with all but Na forming crystals upon sublimation. All compounds are air sensitive and extremely pyrophoric thus all work was accomplished in an inert atmosphere. Preliminary X-ray diffraction studies have shown the Cs complex to be in the orthorhombic space group P_{bcm} with lattice parameters $a = 8.01 \text{ \AA}$, $b = 10.45 \text{ \AA}$, and $c = 10.34 \text{ \AA}$, while the Rb complex is in the tetragonal space group I_{41}/amd with lattice parameter $a = b = 9.93 \text{ \AA}$ and $c = 8.14 \text{ \AA}$. Based on these studies and other information obtained from infrared studies, mass spectra and elemental analysis, the structure is postulated to be one in which the azide is bridged in an allenic fashion between the two aluminum atoms with the terminal nitrogens being Sp^2 hybridized.

SPECTROSCOPIC INVESTIGATIONS OF THE FLOURENYL DERIVATIVES OF THE
LANTHANIDES AND THE ACTINIDES

C. F. Hains and J. L. Atwood
Department of Chemistry
University of Alabama, University

The flourenyl derivatives of Dy, Sm, Ce, and Th were prepared and studied. Mass spectral data suggest the formation of mono-flourenyll complexes of the lanthanides and the di-flourenyl complex with the thorium. Infrared spectra of the green dysprosium, the red samarium, and the yellow thorium complexes indicate the possibility of some covalency in the bonding, although HMO calculations have indicated that the metal would be centered over the C₉ position:



or, at least, over the five-membered ring.

DETERMINATION OF CYANIDE BY FAST SWEEP POLAROGRAPHY

Raymond E. Isbell and Euel R. Cutshell
Department of Science
Florence State University
Florence, Alabama

A modified stripping analysis procedure was developed for the determination of cyanide ion concentration in solutions containing less than 0.3 ppm cyanide. In the procedure, a hanging mercury drop electrode is made instantaneously 0.70 volts negative with respect to a saturated calomel electrode in a solution containing cyanide ion and 0.01 M potassium hydroxide. The length of time the electrodes remain at this potential is unimportant. The hanging mercury drop electrode is then made more positive at a convenient rate in the range of 15-45 mv/sec. At -0.26 v the cyanide which was reduced at -0.70 v gives a polarographic wave as it is oxidized at the mercury electrode.

The ratio of concentration of cyanide ion to diffusion current, C/I_d , is not constant for different concentrations. The rate of change of the ratio, however, is constant so that a working curve obtained by plotting diffusion current as a function of cyanide ion concentration is a straight line.

Abstracts

THE FORBIDDEN TRANSITION AND ITS ROLE IN THE ESR SPECTRA OF α -CHLORO ORGANIC RADICALS

L. D. Kispert
Department of Chemistry
University of Alabama, University

For electron spin resonance (ESR) spectra describable by an equation linearly dependent on field and hyperfine splitting constant, the identity of the radical species involved is made easy by the appearance of $2I + 1$ lines for each interacting nucleus. On the other hand, to properly describe the ESR spectra of α -chloro organic radicals requires a spin Hamiltonian composed of the nuclear and electron zeeman terms, the hyperfine splitting term and quadrupole coupling term which gives rise to a calculated spectrum describable by non-linear magnetic field terms and the appearance of more than $2I + 1$ ESR lines. In such a case the identification of the radical species under investigation is hard to determine. By varying the chlorine-35 quadrupole coupling constant in a calculation where the chlorine hyperfine splitting for CCl_2 and CCl_3 radicals was equal to 18 gauss (typical splitting for a direction perpendicular to the radical plane), it was shown that "forbidden lines" ($\Delta m_I \neq 0$) appeared at lower and higher field positions than the "allowed lines" ($\Delta m_I = 0$) for $Q_z = -.00036$ to $-.00046 \text{ cm}^{-1}$ and were an order of magnitude weaker than the allowed lines. The large number of intense forbidden lines were calculated to appear inside the high and low field allowed lines and made more difficult the radical identification. However, the calculation still showed that the expected first order width was retained if only the lines with intensity 10 times the outside forbidden lines were measured. In addition if a slightly broader spectrum was assumed, the number of accumulated peaks equaled that expected from first order providing the Q_z value was greater than $-.00036 \text{ cm}^{-1}$.
(Supported by the Atomic Energy Commission)

STRUCTURAL STUDIES OF KIDNEY LEUCINE AMINOPEPTIDASE

P. Melius and M. S. Chen
Department of Chemistry
Auburn University, Auburn, Alabama

Active leucine aminopeptidase was found to require magnesium and zinc ions for maximal activity for leucine amide and leucine-p-nitroanilide substrates. In the reactivation of the enzyme, after Mg^{2+} had been removed by dialysis, a significant difference was found, in that the leucine-p-nitroanilidase activity was reactivated to a higher level than the leucineamidase activity. It was found that Zn^{2+} was retained by the enzyme upon hydrolysis against tris·HCl, pH 7.7 buffer, whereas Mg^{2+} was completely removed. This resulted in almost complete inactivation of the enzyme. Upon dialysis against tris·HCl, pH 7.7, $1 \times 10^{-3} \text{ M}$ ZnCl_2 the activity was completely destroyed. Four gram-atoms of Zn^{2+} were detected per mole of enzyme (250,000 g).

SOME REACTION CHEMISTRY IN THE $K[Al_2(CH_3)_6SCN]$ MELT

P. A. Milton and J. L. Atwood
Department of Chemistry
University of Alabama, University

Trimethylaluminum reacts with potassium thiocyanate to form a white crystalline complex of stoichiometry $K[Al_2(CH_3)_6SCN]$ (mp=101°C). Infra-red spectra show the characteristic CN stretch at 2070 cm^{-1} . This is consistent with a structure involving either a sulfur bridging or head-to-tail bridging thiocyanate group. Steric considerations rule out the sulfur bridged geometry. NMR studies at a variety of temperatures are inconclusive. The melt is initially colorless, but prolonged heating at temperatures in excess of 120°C causes decomposition of the anion. The principal product is the isopropylidenaminodimethylaluminum dimer. Verification is found in X-ray diffraction data. Several substances have been found to react with the melt: $MoCl_5$, $ThCl_4$, $CoCl_2$, $CuCl$, $(C_6H_5)_3As$. Studies aimed at the isolation and characterization of the new compounds are in progress.

OXIDATION IN AIR OF TUNGSTEN CONTAINING DISSOLVED OXYGEN

Vernon A. Nieberlein
U. S. Army Missile Command

Vapor-deposited tungsten was deliberately contaminated with oxygen and other elements during the deposition process. These specimens were then oxidized in dry air at 600°-1000°C and at a pressure of one atmosphere. A recording balance was used to measure the weight change and an IBM-1620 computer was used to analyze the data.

A definite relationship was found to exist between the oxygen content of the metal and the oxidation rate in the interval of 700° to 900°C. Using Hoar and Price's model of Wagner's theory of oxidation, the effect of dissolved oxygen in the metal could be explained as an alteration in the driving force of the reaction.

SIMULATION OF LIQUID CRYSTALLINE-TYPE ELECTRON SPIN RESONANCE SPECTRA: THEORETICAL CONSIDERATION AND MODEL OF PREFERRED AVERAGING

T. Pietrzak
University of Alabama, University

Consideration is given to the structural model of nematic mesophases. There exists axial symmetry about the long axis of the liquid-crystal molecules and appropriate nitroxide spin-labels may be introduced as solute probes. The ESR spectra of these probes can be correlated with ordering parameters which may correspond to the ordering of the solvent molecules. Perfect ordering would occur with the nitroxide spin-label long axis parallel to the static magnetic field and increasing degrees of lesser order can be described by the probe molecule (N-O bond) being allowed to do a random walk within a cone limited by a θ_{MAX} angular

Abstracts

deviation from the principal axis along the N-O bond at perfect ordering. A computer model simulates the variation of the three-line isotropic type spectra one observes and lends interpretation to $\langle A \rangle$ hyperfine splitting variation and g value variation as dependent on ordering parameters as one experimentally observes in nematic mesophases upon varying the temperature of the mesophase.

ON-LINE DATA ACQUISITION OF RAPIDLY DECAYING ESR SPECTRA

Jerry Pruett and L. D. Kispert
Department of Chemistry
University of Alabama, University

A Varian data machine's 620/i computer interfaced to an electron spin resonance (ESR) spectrometer has been programmed to acquire rapidly decaying ESR spectra. By using a Varian rapid scan unit and an analog to digital converter capable of digitizing at a rate of 30,000 conversions per second, rapid sweeping of a magnetic field and data acquisition permits thermal decay studies of trapped electrons in irradiated glasses and flow studies using a minimum quantity of reactants. The problem associated with the software programming has included the generation of sweep ramps required to drive the rapid scan unit, the proper ESR spectral addition of repeated scans, the software logic to properly retain the necessary time sequences and the plotting of the data on an x-y recorder. These problems and the software programming method used are discussed. (Supported in part by the Atomic Energy Commission and the National Science Foundation)

EXPERIMENTAL AND THEORETICAL ELECTRONIC DISTRIBUTION IN 2-FURANYLMETHYL RADICAL

R. C. Quijano, C. U. Pittman, Jr., and L. D. Kispert
Department of Chemistry
University of Alabama, University

The electron spin resonance (ESR) spectrum of 2-furanylmethyl radical was obtained and the hyperfine splitting constants evaluated at 3214.5 Gauss and 9.5 GHz. The radical was obtained by steady-state UV (2100 Å) photolysis of 2-methylfuran and *tert*-butyl peroxide (90% and 10% respectively) at -80 C. A total of 32 lines are observed as a result of interaction of the free electron with 5 inequivalent protons.

Using geometric bond distances and angles found in the literature for furan and adding a methylene group, INDO calculations were performed, until a minimal energy was obtained indicating the most stable conformation. The splitting constants thus calculated agree remarkably well with the experimentally determined constants.

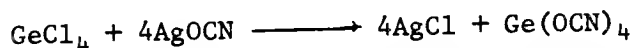
Calculation of the energy difference between two conformations of the methylene protons gave the barrier to rotation of the radical center proton as 25.6 kcal/mole. The magnitude of this barrier to rotation explains the preference of the methylene protons to be coplanar with the furan ring, and thus the inequivalence observed in the methylene proton splitting constants (13.01 and 13.32 Gauss).

π -bond orders and free electron spin density distributions as well as valence electronic distribution were calculated (INDO). The results show the radical to be resonance stabilized; the distribution and delocalization of free spin density is as expected in terms of valence bond resonance theory. The g-values of benzyl, 2-furanylmethyl and 2-thenyl radical were measured, they are respectively 2.0025, 2.00269, and 2.00326. (Supported in part by PRF grant #1495-G2 and by the National Science Foundation)

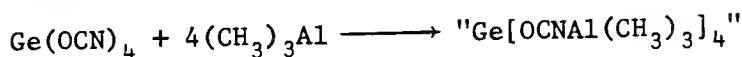
THE REACTION OF ORGANOGERMANIUM PSEUDOHALIDES WITH ALUMINUM ALKYLs

D. H. Roberts and J. L. Atwood
Department of Chemistry
University of Alabama, University

As part of a general plan to study species isoelectronic with $[R_3Al-X-AlR_3]^-$, we have attempted the preparation of $R_3M-X-AlR_3$ (M = Si or Ge, X = pseudohalide) and related substances. Germanium tetracyanate was prepared by the reaction



The pale yellow liquid, $Ge(OCN)_4$, was distilled and reacted with excess trimethylaluminum:



The remaining $(CH_3)_3Al$ was removed under vacuum and the residue was heated to 50°C. A quantity of colorless platelike crystals were obtained by sublimation. The compound is extremely air-sensitive and quite soluble in benzene. The nuclear magnetic resonance spectrum shows two signals in area ratio 1:2 at 9.71 and 10.00 τ .

NEW DEVELOPMENTS IN ORGANOSCANDIUM CHEMISTRY

K. D. Smith and J. L. Atwood
Department of Chemistry
University of Alabama, University

Current interest in organoscandium chemistry is two fold: (1) possible synthetic and catalytic applications and (2) the study of these compounds may give new insight into the principles of bonding and reactivity in organometallic chemistry.

Dicyclopentadienylscandium chloride was prepared by the Coutts and Wailes method. Magnesium cyclopentadienide was reacted with scandium trichloride in THF to introduce the chloride ligand in the product. Dicyclopentadienylscandium chloride can be used to prepare many new organoscandium compounds by replacing the chloride ligand by other ligands, e.g., acetate, acac, etc.

Crystallographic data show the dicyclopentadienylscandium chloride crystal to be monoclinic and have lattice parameters of: $a = 13.63 \text{ \AA}$,

Abstracts

$b = 16.00 \text{ \AA}$, $c = 13.39 \text{ \AA}$, and $\beta = 93^\circ 35'$. Work is progressing on the preparation of an analogous series of indenyl compounds.

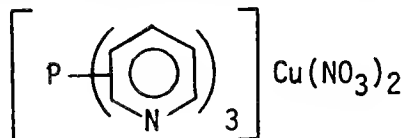
INFRA-RED STUDIES OF PRESSURE EFFECTS OCCURRING IN KBr PELLETS

D. A. Zatko and R. K. Boggess
Department of Chemistry
University of Alabama, University

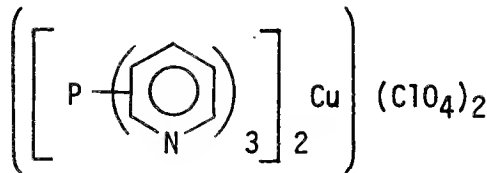
Classically two methods of solid sample preparation have evolved in chemical studies: the mull technique and the pressed KBr pellet technique. The pressed KBr pellet has the advantage of nearly complete transparency in the normal IR range, 4000 to 400 cm^{-1} . The mull technique has found favor in work with samples that react with KBr and in cases where the presence of water in the KBr is not desirable.

Although all chemists should examine the IR of a sample in both matrices, many have fallen into the habit of using the KBr pressed pellet because of the absence of interfering peaks. Many experimenters likewise use the mull technique exclusively, judging the KBr technique non-informative because it may react with the sample visibly.

Two examples of pressure effects are discussed here: 1) In the case of the complex



the covalent nitrates (as seen by the mulled sample,) are displaced by bromide when pressed with KBr and become ionic. The IR spectra easily distinguish covalent from ionic nitrates. 2) In the case of



the Nujol mull gives an IR spectrum exhibiting ionic perchlorate ions while the pressed KBr pellet spectrum shows the type of spectrum exhibited by covalent perchlorates. Actually the perchlorates are not covalent but simply distorted by the KBr lattice in a manner that approximates the covalent symmetry of bidentate perchlorate.

GEOLOGY

A PROBABLE IMPACT STRUCTURE NEAR WETUMPKA, ALABAMA

Robert D. Bentley, Thornton L. Neathery, and Gregory C. Lines
Geological Survey of Alabama, University, and
United States Geological Survey, Montgomery, Alabama

A probable meteorite impact structure is located near Wetumpka, Alabama, $32^\circ 30' 42'' \text{N}$; $36^\circ 14' 12'' \text{W}$, along the boundary between the Gulf

Coastal Plain and Piedmont physiographic provinces. Structural evidence of impact origin is: (1) a dome, approximately 4 mi in diameter, having a rim of metamorphic rocks surrounded by Cretaceous sediments; (2) a circular ridge of schist extending two-thirds of the way around the dome, that stands 200-500 ft above the adjacent Piedmont-fall line peneplain; (3) chaotic structure of Cretaceous sediments in the center of the dome; (4) breccia of schist and Cretaceous sediments in the center of the dome; and (5) concentric faults with estimated displacements of 800 to 1000 ft.

Nowhere along the 1000 mi of Coastal Plain-Piedmont boundary is there any other faulting of the magnitude described in this report. The age of the structure is post-Mooreville (Upper Cretaceous) and pre-terrace (Pleistocene ?). The name Wetumpka Astrobleme is proposed for this structure.

A HORIZONTAL SEISMOGRAPH/CLINOGRAPH WITH ELECTRO-OPTICAL TRANSDUCER

George F. Brockman
Southern Research Institute
Birmingham, Alabama

A horizontal-pendulum instrument was constructed and was found to be suitable for transducing seismic waves in the usual seismic bands long-period seismic waves, and clinographic waves. The 18-cm pendulum was mounted in a Milne suspension inside a Pyrex housing, and adjustment was provided by a kinematic double-slide at the upper support point. The transducer consisted of a blade attached to the pendulum and a pair of fixed blades arranged to form counteroperative masks over a pair of photoresistors. The electrical output is of the order of 2 mv/ μ m. The electrical sensitivity and stability were excellent and the output was found to be linear over a range of about 5 min.

CONIFEROUS WOOD FROM THE TUSCALOOSA OUTCROP AREA IN ALABAMA AND GEORGIA

Elizabeth Cahoon
Auburn University, Auburn, Alabama

Of the many specimens of silicified wood studied from the outcrop area of the Tuscaloosa Group, only three are coniferous. All the others belong to a new Alabama species of the dicotyledonous genus *Paraphyllanthoxylon*. The three coniferous specimens are from Colbert and Lee counties in Alabama and from Fort Benning, Georgia. These all resemble the wood of the Cupressaceae (cedar family). The following description is based on the Georgia specimen, which was the best preserved.

Growth rings are terminated by 2-4 rows of radially short tracheids. Tracheids have uniseriate, circular bordered pits on the radial walls. Occasionally pits are biseriate, opposite. Wood parenchyma strands are common and frequently contain resin. The walls are uniform, without obvious pitting. The distribution is random with no tendency to occur in tangential bands. The rays are usually uniseriate and 2-21 cells tall.

Abstracts

A few rays are partially biseriate. Resin is sometimes present. Ray tracheids are lacking. Crosspit fields, where preserved, had one cupressoid pit. Ray cell walls are very uniformly thin and lack indentures.

Among living North American conifers this wood most closely resembles *Libocedrus decurrens*. It resembles even more closely the wood of the New Zealand species *Libocedrus bidwillii* and the South African tree *Widdringtonia*, all Cupressaceae.

Coniferous leaves and branches from the Tuscaloosa Formation in Alabama were referred to by E. W. Berry as *Widdringtonites*. The fossil wood from Georgia belongs in the form genus *Widdringtonoxylon*. It is not identical with the type species *W. borealis* Penny, 1947 from the Magothy of Delaware. According to Penny many of the Mesozoic woods described as *Cupressinoxylon* should be transferred to *Widdringtonoxylon*.

FURTHER DATA ON THE TALLADEGA GROUP, CHILTON COUNTY, ALABAMA

Thomas J. Carrington
Department of Geology
Auburn University, Auburn, Alabama

The occurrence and identification of fossil spores in low-rank metasediments in northern Chilton County, Alabama, has supported the Devonian age formerly assigned to the Jemison Chert on the basis of megafossils, and the tentative assignment of Devonian and Pennsylvanian ages to other units. This, together with the identification of Ordovician carbonate rocks in the northwestern periphery of the metasedimentary belt, aided in the definition of two major structural blocks within the Talladega belt in Chilton County.

The northernmost structural block, containing some Ordovician but mostly Carboniferous metasediments, consists of a generally eastwardly trending, isoclinally folded syncline that has been refolded so that large-scale cross-fold axes trend in a northerly to northeasterly direction. The (meta-)Newala Limestone and (meta-)Lenoir Limestone of Ordovician ages; the (meta-)Floyd Shale of Mississippian age; and the (meta-)Parkwood Formation, Brewer Phyllite, Sawyer Limestone, and an unnamed sandy phyllite of Pennsylvanian ages are recognized.

The southernmost structural block has been thrust onto the southern overturned limb of the Carboniferous block, and has been folded so that large-scale cross-folds trend in a northerly to northeasterly direction. Metasediments of Devonian ages mapped are in ascending order: an unnamed black phyllite, Jumbo Dolomite, conglomeratic greywacke (with quartzite members), Butting Ram Sandstone and Jemison Chert.

A STATISTICAL APPROACH TO THE PALYNOFLORAL BIOSTRATIGRAPHY OF THE COKER FORMATION (UPPER CRETACEOUS), WESTERN ALABAMA

Raymond A. Christopher
Department of Geology
Auburn University, Auburn, Alabama

A regression analysis was performed on the relative abundance of 158

miospore species from samples of two cores of the Coker Formation (Upper Cretaceous) of western Alabama in order to separate species with vertical distribution partially or wholly controlled by changes in lithology from those controlled only by changes in the linear, quadratic and cubic effects of depth. On the basis of miospore species, which were lithologically controlled, the following conclusions were made: 1) poorly sorted sediment contains a greater proportion of these species than does well sorted sediment; 2) an optimum median grain size exists for use in palynofloral analysis which has no control over the relative abundance of these species; and 3) lithologic control of miospores can be characterized regardless of morphologic similarities and differences among them. The concurrent ranges of 21 miospore species, for which relative abundance was controlled only by changes in depth in both cores, were used to establish three florizones. The florizones were recognized in both cases, and provided the basis for biostratigraphic correlation of the cores.

A high degree of geographic variation in relative abundance of miospore taxa was noted and, although several hypotheses can be advanced to explain this variation, the cause remains unknown.

APPALACHIAN GEOLOGY, ORE DEPOSITS AND CONTINENTAL DRIFTING

Otis M. Clark, Jr.

Geological Survey of Alabama, University

The theory of continental drifting is receiving increasing acceptance, and it is time to apply the theory to regional problems of local interest and to the problems pertaining to ore deposits. The theory showing North America, Europe, and Africa joined as a super-continent and drifting apart in the late Mesozoic is probably an oversimplification. Considering Appalachian structure, it is suggested that more than one tension, cracks and rift, occurred. Also there may have been reverse movement in at least two periods causing compression and structural deformation.

The Appalachian Valley and Ridge and Piedmont provinces are postulated to be a super-rift zone which extended from what is now central Alabama to northern Norway. The split started in the late Precambrian Era and formed a trough that collected sediment through the Paleozoic Era. The many similarities in sedimentation and structure from northeastern Alabama to western Europe give some proof of a rift zone between two continental masses, although shallow seas extended on both sides of the rift zones part of the time. Facies changes in sedimentary rocks of Paleozoic age in Alabama indicate an eastern or southeastern source. Considering continental drift, this would be Africa. It would be hard to explain Appalachian structure and sedimentation without an eastern continental source.

Bauxite is an indicator of past climate, because bauxite deposits indicate warm humid climate at the time of formation. Bauxite deposits can be correlated on both sides of the Atlantic with respect to time. Older deposits occur farther north, and this indicates a progressive change in climatic zones from late Precambrian to Pliocene.

Metallic ore deposits of eastern United States are in many ways similar to ore deposits in western Europe and northwest Africa. The pyrrhotite-pyrite-chalcopyrite massive vein deposits occur in both Europe and

Abstracts

United States. The lead-zinc-fluorite-barite, known as the Mississippi Valley Type, occur in Paleozoic limestone in the United States west of the "rift zone" and in Europe and Africa east of the "rift zone."

SPECIFIC CONDUCTANCE PARAMETERS FOR RELATING STREAMFLOW QUALITY TO ROCK TYPE

E. R. German and C. F. Hains
United States Geological Survey
University, Alabama

Specific conductance and discharge data from 27 sites in north central Alabama have been used in a model to calculate three water-quality parameters (n , Ap_2 , and BQ_2) for each site. The parameter n is the exponent of discharge in a dilution model. Ap_2 and BQ_2 are specific conductance values, obtained from the model, corresponding to conditions of a flood of 2-year recurrence and a median annual 7-day low flow, respectively. Normal ranges for the three parameters have been defined for streams receiving water from limestone formations and for streams receiving water from non-limestone formations. Abnormal parameter values may indicate pollution.

A GEOLOGIC INDEX IN PARAMETRIC HYDROLOGY

C. F. Hains
United States Geological Survey
University, Alabama

A numerical parameter related to the effect of rock type on time distribution of runoff was used in a regression analysis between 40 streamflow parameters and 13 areal parameters, including area, slope, elevation, etc. Data were used from 161 sites in Alabama and adjacent areas. The numerical parameter for geology was an effective index in relations of areal parameters to extreme values and seasonal (monthly) flows. No significance was noted in its relation to average annual flows which smooth the seasonal conditions.

PETROGENESIS OF AN EXPOSURE OF THE CAMP HILL GRANITE

Frank O. Hollinger
University of South Alabama, Mobile

The southern portion of the Dadeville Complex is characterized by extensive areas of granitic rocks, which are called the Camp Hill Granite. Detailed sampling, and petrographic and X-ray analyses of the rocks from the Saugahatchee Creek locality, reveal a range in rock type from quartz diorite to quartz mononite to granite, with associated pegmatites. This is thought to illustrate differentiation of an anatectic melt within a relatively small igneous "pod", in this case less than 800 ft in width.

This appears to be a classic example of a crystallization product of a melt formed from the fusion of geosynclinal sediments under conditions

of elevated water pressure and tectonic activity. The composition can be shown to be proportional to that of a mafic poor greywacke. The presence of primary muscovite (and comparison to the stability field of muscovite) leads to the assumption of a water pressure in excess of 4,000 bars. Temperature trends of crystallization can be computed for varying water pressures with the use of the ternary diagram for systems $\text{NaAlSi}_3\text{O}_8$ - KAlSi_3O_8 - SiO_2 - H_2O .

FLUID INCLUSIONS IN BARITE AND FLUORITE FROM
BIBB COUNTY, ALABAMA

Travis H. Hughes
University of Alabama, University

The mineral deposit on the Weaver Property occurs in Faulted Newala limestone and is predominantly barite, but contains minor amounts of fluorite and calcite. Mineral deposition occurred in two distinct stages separated by a period of brecciation. Fluorite and calcite were congenetically deposited as an intermediate stage during barite deposition.

Primary fluid inclusions in fluorite indicate a range in depositional temperatures (uncorrected for pressure) of 91°C to 73°C. Field evidence and secondary fluid inclusions indicate almost continuous fracturing or brecciation throughout the depositional history of the mineral deposit.

OCCURRENCES AND ASSOCIATED STRUCTURES OF BARITE IN
CALHOUN COUNTY, ALABAMA

Bob Lynch
University of Alabama, University

The age of mineralization in Calhoun County seems to be directly related to the Appalachian deformation of the Cambrian-Ordovician sediments. There also seems to be two distinctly different types of barite occurring in the county. One type is the unaltered vein type and the other is a crushed and sheared massive type. This sheared type of barite occurs in the residual soils above the Chepultepec-Knox cherts.

This project is concerned with four more representative locations of the twelve known occurrences of barite in Calhoun County. Two of these occurrences are in the proximity of thrust faults with the barite occurring in a narrow slice of limestone (Newala lithology) between two thrust faults. The other two occurrences are also near thrust faults, but are vein barites in the Chepultepec chert.

A MEANDER BELT DEPOSIT IN THE TUSCALOOSA GROUP (UPPER CRETACEOUS)
IN LEE COUNTY, ALABAMA

Nancy Meroney
Auburn University, Auburn, Alabama

Tuscaloosa sands and gravels in Lee County, Alabama, are part of a

Abstracts

fluvial depositional system. The depositional type represented in an exceptionally revealing roadcut exposure of Tuscaloosa sands and gravels is interpreted to be a meander belt deposit. The interpretation as a meander belt deposit is supported primarily by sand body geometry, texture, and internal structures. The particular roadcut exposes in cross-section a point bar that is terminated laterally by a channel fill. The point bar deposit consists of a basal layer of gravel and an overlying wedge of cross-bedded sand and gravel that thins toward the channel. The channel is filled with horizontally bedded fine grained sediments.

The coarse detritus and low surface of the point bar suggests that this portion of the stream channel was broad.

The described depositional framework is consistent with the principal characteristics of the idealized fluvial model proposed by Visher (1965).

ENVIRONMENTAL GEOLOGY IN ALABAMA

Paul H. Moser

Geological Survey of Alabama, University

The Alabama Geological Survey investigates and documents the natural resources of the state. The documented results of the investigations are widely distributed and serve as the foundation of a series of comprehensive investigations concerning the use of natural resources in effective land-use programs.

Texts, maps, charts, and other sources of information are important in describing existing conditions as they occur on or under the ground. The interpretation of data to obtain specific information is left necessarily to the individual trained in various fields of science and not the average layman, who is not schooled in the disciplines of geology, hydrology or engineering geology.

With the recent alarm over the crisis in our environment, the dwindling resources of land and minerals, and the concern for efficient land use, the Alabama Geological Survey is now emphasizing the importance of making available to the layman such maps, charts, texts, and basic data in the accessible form of use maps that he may use the land more efficiently. Interpretive use maps are created through the process of "building," i.e., the compilation and interpretation of basic data maps. These interpretive use maps show graphically by color codes the areas most suitable, moderately suitable, and least suitable for specific uses.

The end product is the interpretive use map that is usable and understandable by the planner, industrialist, layman, and the general public.

SINKHOLE PROBLEM IN AND NEAR ROBERTS INDUSTRIAL SUBDIVISION BIRMINGHAM, ALABAMA: A RECONNAISSANCE

J. G. Newton and L. W. Hyde

United States Geological Survey and
Geological Survey of Alabama, University

Sinkholes in and near Roberts Industrial Subdivision along Village Creek in Birmingham, Alabama have resulted in costly damage, major pollution, and narrowly averted accidents. It is estimated that more than

200 collapses and areas of subsidence formed in an area of less than half a square mile during 1963-70. Sinkholes and subsidence have occurred in streets and parking lots and beneath railroads, sewer and water mains, office buildings, warehouses, and Interstate Highway 59.

A major lowering of the water table, estimated to be as much as 140 ft, resulting from ground-water withdrawals makes the area prone to the development of sinkholes. Barring recovery of the water table, sinkholes will continue to form with the greatest activity occurring during months of heavy rainfall. The continuing number of collapses, their location, and their sudden occurrence at times indicate possibilities of serious accidents.

The formation of sinkholes results from the collapse of cavities in residual clay that have been created by "spalling" or the downward migration of clay through openings in underlying carbonate rocks. The spalling and formation of cavities is caused by or may be accelerated by: lowering of the water table resulting in a loss of support to clay overlying openings in bedrock; fluctuation of the water table against the base of residual clay; downward movement of water through openings in clay; and increased velocity of water in cones of depression to points of discharge. Collapses have occurred where spalling and the resulting enlargement of cavities has progressed upward until overlying clay would not support itself, and where sufficient vibration, shock, or loading over cavities caused the clay to be jarred loose or forced down.

EVALUATION OF TECHNIQUES FOR SELECTING SITES FOR INDUCED INFILTRATION ALONG THE ALABAMA RIVER: CONCLUSIONS AND ACCOMPLISHMENTS

Leon Scarbrough
Geological Survey of Alabama, University

This study included applications of photogeology and geophysical and auger test drilling methods in the flood plain of the Alabama River to locate and define deposits which would be good shallow aquifers with definite potential for hydraulic connection to the river.

Aerial photographs were studied to assist in locating abandoned river channels and other areas in which shallow aquifers might exist. The prospective areas were then investigated with geophysical methods and auger test drilling. Refraction seismic and electrical resistivity methods were used to attempt to locate sand and/or gravel deposits. Electrical resistivity became the primary geophysical method used when experience indicated that sand and gravel deposits were more resistive than the associated clay and silt deposits. Old abandoned channels consisting of sand and gravel were located and thickness of the bodies was determined from seismic data and auger test drilling.

The deposits that proved best for large quantities of water were ancient abandoned channels that consisted of basal gravels of 2 inches in diameter overlain by smaller gravel and coarse sand. These deposits usually have thicknesses of 20 to 60 ft.

Five large diameter test wells with pumping test proved that large quantities of good quality water could be recovered from the flood plain aquifers.

Abstracts

ARE LUNAR ROCKS IGNEOUS IN THE SAME SENSE AS EARTH ROCKS?

Reynold Q. Shotts
University of Alabama, University

Sufficient time has now elapsed in which to form opinions on the geological history of the moon, based on a study of rocks returned from the Apollo 11 and 12 missions. Several published papers apparently have summarized a prevailing "concensus" especially one by Ralph Baldwin (Science 170: 1297-1300, 1970). Essentially, it suggests initial melting (4.5 b.y. ago) accompanied by differentiation and followed by solidification of a moonwide crust 10-16 km thick. The crust continued to thicken and, when the impacts that produced "dry" circular maria began, was at least 50 km thick. Flooding of the maria by lava began about 3.5 b.y. ago. These lavas came from depths of 200-400 km, well below the "solid" crust. The "crust" is essentially anorthositic in character and the mare filling is basaltic.

The accepted mechanisms of the origin and emplacement of igneous rocks in the earth are compared to the above outline of lunar processes and the title question raised, especially with regard to the rocks of the lunar highlands.

Study of the 100 lb of rocks returned from the Fra Mauro Imbrian "splash" feature by Apollo 14 may soon throw more light on the possible presence and character of an anorthositic crust. Judging by the results of lunar exploration to date, however, these rocks may possibly raise more questions than they answer.

SOME FACTS REGARDING THE DISTRIBUTION OF REMAINING RECOVERABLE COAL RESERVES OF ALABAMA

Reynold Q. Shotts
University of Alabama, University

Last year the author reported on methods of estimation and on total and strippable coal reserves of Alabama based upon Culbertson's total reserves, estimated as of 1/1/58, and on a new and first estimate of strippable reserves as of 1/1/68. The work was part of the present coal reserve program of the U.S. Bureau of Mines. Further work has up-dated both estimates to 1/1/71 and the distribution of these reserves by coalfields, counties, and coalbeds is reported in this paper.

Tables show both tonnage and percentage of remaining recoverable coal reserves suitable for strip mining and for underground mining, both by coalfields and counties and by coalfields and coalbeds, as of 1/1/73. The distribution of total reserves as of 1/1/58, by depth and by thickness categories, is presented. Shown also are ratios of total to strip-pable reserves by counties and by coalbeds.

Some remarks are made regarding limitations on the estimates, their incompleteness, and the location of possible additional reserves that might be proved by exploration.

PETROGRAPHY AND WEATHERING OF SILICASTONE OF THE
FORT PAYNE FORMATION

Richard G. Stearns and John M. Wilson
Vanderbilt University and
Tennessee Division of Water Resources
Nashville, Tennessee

Silicastone (approximately $\frac{1}{2}$ silica and $\frac{1}{2}$ carbonate) forms the surface bedrock over large areas of the Highland Rim in Tennessee, Kentucky, and Alabama because of its resistance to erosion. In large outcrops the rock occasionally includes cut-and-fill structures as thick as 30 ft. Within these irregular rock masses large-scale bedding (1 in. to 3 ft) is mostly even. Microbedding (visible in hand specimens) is irregular and considerably contorted.

Microtextures, however, are almost all destroyed and the original rock is typically recrystallized into carbonate rhombs imbedded in a matrix of chalcedony. The average composition of the rock approximates 50% chalcedony, 10% quartz, 25% calcite, 12% dolomite, 2% pyrite, and 1% glauconite and other minerals including clays. The most common fossils are sponge spicules (now chalcedony) which are common even in residuum.

Weathering of silicastone is generally uniform with a relatively flat contact between top of bedrock and base of residuum. Along vertical joints, weathering may extend 30 ft or more into bedrock. The weathering process consists mainly of leaching soluble carbonates from bedrock. This leaching is also accompanied by the replacement of carbonate crystals by silica.

JAW MECHANICS AND PALEOECOLOGY OF LOWER CRETACEOUS PYCNODONT
FISHES FROM TEXAS

John T. Thurmond
Department of Geology
Birmingham-Southern College
Birmingham, Alabama

The Pycnodontiformes are a comparatively little-known order of Mesozoic and Early Tertiary fishes with a dentition adapted for crushing food. The pycnodont jaw consists of four functional elements. The premaxillae above and the dentaries below are the most anterior elements and bear incisiform teeth. The crushing battery consists above of a medial element, the vomer, and below of paired splenials. These elements bear flattened crushing teeth.

Study of jaw function in these fishes, based on jaw structure and tooth wear, indicates that there are two basic types of jaw action which reflect a taxonomic dichotomy within the order. A group typified by the Tertiary *Pycnodus* and the Mesozoic *Macromesodon* (*Mesodon* of most authors) show a rounded transverse profile of both vomer and splenial grinding surfaces, a fairly rigid splenial symphysis, and an even distribution of tooth wear. This reflects a simple crushing and grinding jaw action suitable for eating corals and echinoids, and perhaps mollusks. A minute new genus of this group may have specialized in ostracods and conchostracans.

Abstracts

In contrast, the other group, based on *Proscincetes* (*Microdon* of most authors), shows a deep U-shaped cross-profile of the paired splenials, a straight edge to the vomer, wear facets on the lateral surface of the vomer, and immovable splenial symphysis. This jaw is capable of considerable shearing in addition to simple crushing, perhaps allowing addition of cephalopods and arthropods to the diet.

FORESTRY, GEOGRAPHY, AND CONSERVATION

THE GEOGRAPHIC EXTENT OF WHOLESALE TRADE IN TUSCALOOSA, ALABAMA

Harriett Joanne Bonham
University of Alabama, University

The purpose of this study was to determine the geographic extent of Tuscaloosa's wholesale trade service area. Previous work in this field has not yielded any theory or formula similar to that of the retail trade area study by William J. Reilly.

Information was gathered by private interviews from wholesale firms in the Tuscaloosa city limits. The total area served by the five firms was then compared to a theoretical model proposed in the study.

The conclusions were: (1) Tuscaloosa's wholesale trade area was elongated to the north and south. (2) Wholesale groceries had a larger trade area than non-perishable goods. (3) Most of the companies interviewed concentrated their sales in the same eleven counties. (4) The state line and Jefferson County, in which Birmingham is located, limit Tuscaloosa's wholesale trade area to the west and east, respectively.

In summary, Tuscaloosa's wholesale trade area generally conforms to the theoretical model because its hinterland is not disrupted by any physical relief and the city is located near the center of west Alabama. Tuscaloosa is interconnected to its hinterland by several major state and federal highways and there is little competition from surrounding cities for wholesale trade within Tuscaloosa's primary trade area which consists of eleven counties.

ALABAMA - LAND OF THE LONGLEAF PINE

Thomas C. Croker, Jr.
U. S. Forest Service
Southern Forest Experiment Station
Brewton, Alabama

Alabama has a unique heritage in the longleaf pine tree. This tree has much potential for building a quality environment in the state, but not enough is being done to realize the benefits. Suggested action includes: (1) designating longleaf pine as the official state tree; (2) locating a new American Forestry Association champion to replace the one that died a few years ago; (3) planting more longleaf pine around homes, interstate highways, schools, public buildings, and similar locations; (4) increased use of a shelterwood-natural regeneration system in the

better stocked second-growth stands; and (5) extending the Appalachian Trail into the longleaf-type in the Mountain Provinces of Alabama.

THE CLEARCUTTING SILVICULTURAL SYSTEM

L. Earl DeBrunner
Department of Forestry
Auburn University, Auburn, Alabama

Clearcutting is a silvicultural system in which all trees, regardless of size or quality, are removed in the harvest operation. The new stand is established by either natural or artificial means. Clearcutting with artificial regeneration is the method that large industrial landowners in the South, particularly those in the paper industry, have adopted. Considering their management objectives, it is a logical choice. Nevertheless, numerous people object to the employment of this system. The objection should not be to the clearcutting silvicultural system, which is sound and proven, but rather to the manner in which it has been applied. Technological "improvements" in site preparation equipment have allowed the widespread use of supplementary site preparation. However, the improvements in this equipment have not included ease of movement from one location to another. The moving operation is expensive. In order to minimize site preparation costs, large areas are treated at each operational area. Engineering improvements for ease of movement of this equipment from place to place would eliminate the necessity of treating large acreages at one location.

A UNIFUNCTIONAL CLASSIFICATION OF ALABAMA CITIES

Jacques Emplaincourt
University of Alabama, University

In 1943, Chauncy D. Harris classified cities in the United States on a unifunctional basis. The purpose of this paper is to consider the eleven Alabama cities that Harris classified in 1943, and compare the same eleven cities classified according to 1963 data.

The procedure for the 1963 classification follows as much as possible the one used by Harris in 1943. The method is based upon economic activities of cities, which are mainly derived from the employment figures of the *Census of Manufacturers*. The functions are obtained from percentages of persons employed in various economic activities.

The results of the study are: (1) that only two cities changed in function, suggesting that once a city acquires a functional pattern (with an established momentum) it tends to keep that pattern for a long period of time; (2) that slight changes may occur in the dominant function which will temporarily modify the classification of a city, but sooner or later the dominant function reestablishes itself; (3) that if major changes occur in the economic activities of a city, the functional pattern seems to shift toward "diversification."

Abstracts

AN ANALYSIS OF THE EVOLUTION OF THE URBAN CHARACTER OF DECATUR, ALABAMA

Michael E. Hardin
Florence State University
Florence, Alabama

Until the depression of 1929, Decatur was the agricultural center in the Tennessee Valley of northern Alabama. Since that date, Decatur has grown at a very rapid rate. This growth is largely attributable to outstanding changes in the basic economy of the area, i.e., from an agricultural one to a largely industrially oriented one.

As Decatur has grown and expanded, the character of the area has changed in accordance. The most significant expansion has been in the form of annexation and incorporation. This expansion can be paralleled with the increasing industrial contributions.

Decatur is very similar to other related urban areas in some respects, and very different in others. Decatur has problems caused by its rapid growth, and it also has outstanding assets which may be attributed to its growth.

Finally, when viewed in terms of contemporary concepts, projections for the future evolution of Decatur's urban character come more easily into perspective.

RARE, ENDANGERED, AND DEPLETED FRESHWATER FISHES OF ALABAMA

John S. Ramsey
Department of Fisheries and Allied Aquacultures
Auburn University, Auburn, Alabama

The conservation status, distribution, and threats to the wellbeing of 24 species of Alabama freshwater fishes are discussed. Extinct species include *Lagochila lacera* and *Fundulus albolineatus*. *Etheostoma nuchale*, an endangered species, is restricted to a single spring in Bessemer, Alabama. Rare fishes include *Notropis uranoscopus*, *Notropis* sp., *Etheostoma trisella*, *Etheostoma* sp., *Percina aurolineata*, and *Cottus pygmaeus*. Depleted species are *Acipenser fulvescens*, *A. oxyrinchus*, *Scaphirhynchus platyrhynchus*, *Noturus munitus*, *Ammocrypta asprella*, *Etheostoma ditrema*, *E. tuscumbia*, and *Percina lenticula*. Species which are bordering on depletion are *Hemitremia flammea*, *Notropis caeruleus*, *N. callitaenia*, *Cycleptus elongatus*, *Moxostoma carinatum*, and two undescribed species of the subgenus *Ulocentra* of *Etheostoma*.

THE KING PHARR CANNING COMPANY

Carolyn June Reed
Florence State University
Florence, Alabama

The King Pharr Canning Company of Cullman, Alabama is the only vegetable canning company in the state. The company began operation in 1914 at Catherine, Alabama where it canned only one product, okra. In

1942, the operation was moved to Cullman, Alabama to can sweet potatoes. The growing demand for canned vegetables, improved means of transportation, and the abundance of fresh vegetables encouraged the company to expand its operation to can all kinds of vegetables. At present, the King Pharr Company owns five plants and has a nation-wide distribution of its products.

Vegetables to be canned are obtained through contract production or brokers. Contracts are negotiated with farmers in the southern states to grow vegetables such as pimentos, yellow squash, okra, green beans, and black eyed peas, while fruits and other vegetables are obtained through brokers.

Employment at the canning plant is seasonal. The Cullman location maintains a small permanent staff and hires workers from the surrounding area; the product being canned determines the number of employees. The recent increase in mobile home production is tapping the same supply of labor.

ALABAMA STATE PARKS

Merle Sherman
Florence State University
Florence, Alabama

The Alabama State Parks and the Outdoor Recreation Division have received an increased amount of state and federal funds in the last five years. The purpose of this paper is to review the objectives of the Alabama State Park system and the new Outdoor Recreation Division within the State Department of Conservation. The history of the state park movement is traced and the various purposes of the Alabama parks outlined. Finally, the impact of the new federal Bureau of Outdoor Recreation on the Alabama program and the resulting changes taking place at present are discussed.

CRITICAL POPULATION DENSITIES WITH RESPECT TO AFRICA SOUTH OF THE SAHARA

James R. Stovall
Florence State University
Florence, Alabama

Population relative to total land mass of a given area may be low, yet islands of pressure can exist areally. Pressure in these pockets may be reaching critical levels when viewed in the light of the carrying capacity of the land under study. In addition to strict numbers analysis and carrying capacity of the land, unequal distribution; birth and mortality rates; migratory patterns; and economic structures should be included among the factors under consideration. In this manner a more accurate picture of density levels and their impact can be achieved. These contentions are examined and pursued with respect to Africa, south of the Sahara in general, and Nigeria in particular.

Abstracts

PHYSICS AND MATHEMATICS

EXPERIMENTAL STUDIES OF OXIDATION RATES ON (100) FACES OF COPPER AND NICKEL SINGLE CRYSTALS

M. H. Anderson, Jr. and A. T. Fromhold, Jr.
Auburn University, Auburn, Alabama

A polarized light spectrometer (ellipsometer) is utilized to follow the time-dependence of oxide film thickness in the range of 5 to 5000 Å during formation on various metal single crystals. The metal crystals are formed by evaporation of 99.999% pure metals with epitaxial growth on NaCl substrates held at approximately 250°C in a vac-ion-pumped stainless steel reaction chamber capable of 10^{-10} torr. A residual gas analyzer is used to monitor the impurity gases. The oxidation is carried out *in situ* in the 10^{-6} to 1 torr range under dynamic conditions by flowing high purity oxygen through the system to a titanium sublimation pump. Optically flat windows in the reaction chamber are accurately aligned perpendicular to the entering and exciting polarized light, and the crystal holder is adjustable for optical alignment of the surface of the metal crystal. Electron microscopy and X-ray diffraction measurements are carried out on the oxides. The kinetics have been studied as a function of temperature and pressure in a preliminary way for silver and nickel, but our best data are for oxidation of (100) copper between 25 and 200°C.

REFLECTION EFFICIENCY OF VARIOUS MATERIALS IN THE X-RAY REGIONS OF 0.8 TO 2.5 nm AND 4.4 TO 8.0 nm

Stanley A. Fields
Space Sciences Laboratory
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

Results of studies to determine the reflection efficiency of optical surfaces at X-ray wavelengths are presented. The experimental results given are those obtained by the author and those which have been reported in the literature. The surfaces tested consist of optically polished samples and vacuum-deposited thin films on these surfaces. Reflection efficiency curves are plotted for all materials which were reported in the literature reviewed. Only one curve is given for each material at a given wavelength regardless of the number of experimenters reporting results. Also, not all wavelengths of radiation are plotted for some materials because it would overcrowd the figure; however, in every case the shortest and longest wavelengths are plotted. The studies cover the X-ray wavelength regions of 0.8 to 2.5 nm and 4.4 to 8.0 nm.

A COAXIAL, HIGH-VOLTAGE SWITCH FOR PLASMA DISCHARGES

P. J. Liroy, E. J. Clothiaux, and H. Weaver
Physics Department
Auburn University, Auburn, Alabama

A coaxial switch capable of use in the 5-18 KV range, having a total inductance of approximately 27 nh for use in conjunction with a plasma focus experiment, is described. Its performance characteristics and motivation for construction are given.

A VACUUM X-RAY REFLECTOMETER

John M. Reynolds
Space Sciences Laboratory
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

The X-ray reflectometer is designed to allow precision measurements of X-ray reflection with an angular resolution of a few seconds of arc. The instrument is used to measure the X-ray reflecting properties of various materials as a function of the finish achieved with different polishing techniques. The reflectometer is a simple, mechanically driven instrument that operates inside an environmental chamber at 1.333×10^{-4} to 1.333×10^{-7} Newtons/m². The primary components of the system are (1) a monochromating crystal, (2) an optical flat, (3) detectors, (4) an X-ray source, and (5) a remote readout system.

A SUMMARY OF RECENT STELLAR X-RAY OBSERVATIONS

Robert M. Wilson
Space Sciences Laboratory
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

This article summarizes recent stellar X-ray observations. A general background review is presented, followed by summarized descriptions of several major topics of interest in current stellar X-ray astronomy studies: simultaneous optical and X-ray investigations of Sco X-1, polarization, emission lines, pulsars, and the diffuse background. Concluding this paper is a discussion of immediate needs of stellar X-ray astronomy.

Abstracts

INDUSTRY AND ECONOMICS

U.S. COPPER MINING INVESTMENTS IN CHILE, 1945-1970

Eric N. Baklanoff
University of Alabama, University

In Chile, as in several other Latin American nations, romantic nationalism has vied with the more pragmatic variety to shape the policies, the terms, and the conditions under which the U.S. companies were permitted to extract, process, and export mineral resources.

The experience of the U.S.-owned copper mining companies in Chile from 1945 to 1970 yields the following significant highlights: (1) Chilean policy toward the U.S.-owned copper companies proved to be highly erratic, shifting between a posture of pragmatic accommodation to the application of onerous and counter-productive tax measures; (2) company responses to these changing "climates" were highly elastic, i.e., decisions to invest, expand output, and engage in exploratory operations were positively correlated with official measures that promised long-run tax stability, moderate tax rates, and security of property; and (3) the viable "Chileanization" or joint-venture approach has yielded to the "final solution" of Chile's copper problem, i.e., involuntary nationalization and ultimately expropriation.

THE CURRENT STATUS OF CONSUMER PROBLEMS IN ALABAMA

Samuel H. Himes, Jr. and Frank Y. Anderson, IV
University of Alabama, University

This study concerns the current state of affairs in Alabama, with regard both to existing state consumer protection laws and to President Nixon's proposed consumer protection program. The paper also includes a discussion of the most prevalent frauds used in the state. After interviewing district attorneys and/or Better Business Bureaus in the five largest Alabama cities, the authors conclude that neither state law nor the proposed federal legislation provides adequate protection for the consumer on the local level. Also, they believe that a comprehensive statewide consumer education program is necessary, in order to inform citizens about consumer frauds. Currently, many consumers are unaware of possible frauds and, even when victimized, are reluctant to prosecute.

DESIGNING A STUDY OF THE INTERACTION BETWEEN MINING AND SOCIETY IN AN URBAN ENVIRONMENT

Henry N. McCarl
Department of Economics
University of Alabama, Birmingham

The paper attempts to define and describe the various parameters of the complex problem of mineral extraction in the urban environment. It concentrates on the methodology of the urban mining study, with particu-

lar emphasis in the area of economic and social benefits and costs of mining activity. Potential methods of quantification of benefit and cost factors are discussed in the context of a regional input-output framework.

SOME IMPLICATIONS OF THE EXPANDING SERVICE ECONOMY

Marian V. Shirley
University of Alabama, Birmingham

Increased demand for services, accompanied by a low growth rate in service technology, has caused a necessary revision in the approach to study of consumer behavior patterns relative to inflationary pressures upon the economy. In reviewing the economic tools at hand, it is evident that the Marginal Utility of money is either approaching a value of zero, or is no longer a method which may be employed in forecasting consumer behavior. Further, there is the basic problem of quantifying and defining services in a manner which will be useful in the framework of existing theory.

A FORECAST MODEL OF TOURIST DEPARTURES FROM EIGHT SOUTHERN STATES TO JAMAICA

A. J. Strickland, III
Department of Management
University of Alabama, University

The purpose of this study was to formulate a theoretical quantitative model to forecast the number of tourists that Jamaica could expect from each of the following states: Alabama, Georgia, Mississippi, Louisiana, Florida, North Carolina, Tennessee, and Virginia. The model chosen was the general linear equation. The dependent variable chosen for the model was the number of tourists going to Jamaica per year. The independent variables used to explain the variation in the number of tourists were grouped in five classifications: income series, population series, education series, cost of travel series, and flight time series. The observation period was the 14 years from 1956 to 1970. Data were collected principally from the U.S. Department of Commerce and Labor, the Airline Industry, and the Jamaica Tourist Board.

A data retrieval system was constructed and all data were stored on magnetic tape or disc with a four key sort code. Stepwise linear regression was used to determine the regression equations. Tests were made for the presence of multicollinearity and autocorrelation. The F-ratio, the Student's t-test, and the coefficient of multiple regression were used to ascertain the statistical significance of the regression equations.

Several conclusions were reached during the research: (1) The linear regression model for each state was capable of explaining the variation in the dependent variable with 95% confidence; (2) the largest errors in forecasting occurred in states that had the fewest people going to Jamaica; and (3) the best indicators of the number of tourists departing for Jamaica were the income series, the population series, and the

Abstracts

cost of travel series.

AGRIBUSINESS POTENTIALS AND PROBLEMS IN NORTH ALABAMA

Harold C. Young, H. A. Henderson, and Gerald G. Williams
Agricultural Resource Development Branch
Tennessee Valley Authority
Muscle Shoals, Alabama

The north Alabama area is one of the most important agricultural areas in the Southeast in terms of concentration of commercial production and changes being made. It includes about 30,000 farms producing farm products worth \$260 million annually. In addition, over 770 farm-dependent firms (firms doing at least 75% of their volume of business with farmers) have a business volume of over \$400 million.

Agriculture in the area is making rapid growth and change. Value of farm products sold grew more than 50% the last 10 years--from \$165 million to \$260 million. The big growth was in poultry which accounted for about half the expansion. Soybeans are replacing cotton and corn as major cash crops. In addition to farm income, 80% of the farmers had nonfarm income of over \$90 million.

Resources are not fully used. At least half of the better land (classes I-III) is not used for crops, and less than half the cropland is harvested each year.

Agriculture in the area could be expanded beyond what it is if resources are more fully used and if tested and proven technology is used. Farm sales could increase from \$260 million in 1968 to an estimated potential of \$655 million. Expanding agriculture causes a whole series of business expansions. Expanding farm sales to \$655 million will generate other direct farm-dependent business to about 54,000 workers and a volume of business of about \$1.2 billion.

These changes will not be automatic or easy to make. There are many things to hinder and resist expansion. The main barriers identified are: (1) Need for improving the management ability of farmers and their ability to use new technology; (2) land is improperly used; (3) land tenure problems discourage adjustment; (4) farm size is limited; (5) human and cultural restraints limit ability to change; and (6) markets need to be expanded.

AN EVALUATION OF PROGRAM ACTIVITIES IN TRIBUTARY AREA DEVELOPMENT, TENNESSEE ELK RIVER COUNTIES

Harold C. Young and R. H. Gibson
Agricultural Resource Development Branch
Tennessee Valley Authority
Muscle Shoals, Alabama

This report illustrates a logic and method of accounting applied to an actual development program. In 1963 TVA, in cooperation with a local citizens organization and other agencies, began a comprehensive development program in Elk River watershed to improve social and economic welfare. A major part of that program was to develop the agricultural industry.

Major objectives were to improve farm incomes through (1) improving

soil fertility and crop production practices, (2) expanding livestock and improving livestock production practices, and (3) improving farm management practices. Activities included special research projects and an incentive fertilizer program. In addition, Valley-wide development activities such as unit test-demonstration farms, fertilizer trials, field demonstrations, and rapid adjustment farms were used more intensively.

During the 6-year program, 1963-1968, TVA invested \$1.25 million in all agricultural activities. In addition, local citizens invested an estimated \$0.50 million to promote the program and related activities.

Before the program began, farm income had been increasing at about the same rate as the rest of the state. After the program started, income increased faster than in other counties. Estimated net farm income was \$7.435 million greater than what it would have been if growth rates had been the same as the rest of the state.

Estimated benefits were about \$5.90 for each \$1.00 spent by TVA. When costs of local citizen participation were considered, there was a benefit-cost ratio of about 4.25 to 1.00.

SCIENCE EDUCATION

AUDIO-TUTORIAL TEACHING OF BIOLOGY IN A SMALL SCHOOL SITUATION

Richard Couch
Biology Department
Athens College, Athens, Alabama

The audio-tutorial concept of teaching biology was first developed by Dr. Samuel N. Postlethwait of Purdue University. Since its conception in the early 1960's, this new teaching technique has been widely adopted by colleges and universities across the United States, especially the larger schools.

After seeing the advantages of the audio-tutorial method over the standard "lab-lecture" method of teaching beginning biology, we decided to try the technique at Athens College. Being small, with a limited budget, we have had to adapt the concept to our particular situation.

Our beginning biology course, BI 101, has been taught utilizing the audio-tutorial method for 2 years. There have been many revisions during these 2 years to better adapt the technique to our situation and improve the learning environment.

Evaluations by faculty involved in teaching the course, student-assistants, and feedback from students taking the course all enthusiastically endorse the course as being superior to the "standard" approach to teaching freshman biology. Students say they learn more, at their own speed, at their convenience, and it allows them to pursue to greater depths the subjects in which they are most interested. The testing program for the course supports the fact that students learn more from BI 101 taught with the audio-tutorial technique. Faculty members in charge of the course find that they have closer relationships with their students as individuals. The course is closer to being individualized teaching than before the audio-tutorial technique was used.

We are quite pleased with the audio-tutorial concept of teaching

Abstracts

freshman biology at Athens College. Needless to say, we intend to continue its use and expand to other courses as facilities and budget will allow.

A STUDY OF MICROTEACHING IN THE IN-SERVICE EDUCATION OF TEACHERS OF ELEMENTARY SCIENCE

Hollis C. Fenn and James E. Lake
Florence State University
Florence, Alabama

A Cooperative College-School Science Program grant supported a 3-week summer workshop for 35 elementary teachers and principals from the Tuscumbia, Alabama City School System. Twenty-four in-service sessions were held during the following academic year to introduce the new materials to all the elementary teachers in the system.

Emphasis was placed on the Elementary Science Study (ESS) but an overview of Science - A Process Approach (S-APA) and Science Curriculum Study (SCIS) materials was included.

During the workshop the teachers were divided into teams of three or four and they took turns teaching groups of children (4-8 per group) the ESS units. Many of these microteaching sessions were videotaped and reviewed by the teachers.

An evaluation of the program was attempted by using Science - A Process Approach Competency Measures as pre and post tests. The teachers in the 3-week summer workshop, who were actually teaching ESS or similar materials, were designated as group A; teachers who were teaching new programs but did not attend the workshop were designated as group B; and group C was composed of teachers who were not teaching the new science materials and had attended neither the workshop nor the in-service sessions.

Twelve processes of science as described in the Science - A Process Approach program were selected (two for each grade level), and two competency measures for each process were given to five students of mixed ability from each teacher as a pre and post test.

Results of the testing showed no significant difference in the three groups. There was some question regarding the validity of using these instruments to evaluate an ESS workshop and in-service program.

HELP FOR THE SECONDARY SCIENCE TEACHERS OF ALABAMA SUMMER INSTITUTES

Elizabeth Manger and Martin C. Manger
Department of Chemistry
Alabama A. and M. University, Normal

A survey of past participants in NSF sponsored institutes indicates that these institutes are of value to the secondary science teachers by providing a method of upgrading their scientific knowledge and gaining familiarity with modern teaching aids. Participants report that they are able to incorporate much of the experimental work directly into their classroom and have gained a much needed sense of security in

teaching scientific subjects. It was concluded that the NSF Institute provides a valuable source of information and aid to science classroom teachers, especially to those who have been away from the college campus for a long period of time and to those who are aware of their own limited background in the subject matter that they must teach.

A CONTINUING STUDY OF ORAL TESTING OF NON-READERS IN SCIENCE

Elizabeth F. Martin
Department of Secondary Education
University of South Alabama, Mobile

One of the greatest problems in elementary and secondary education continues to be the inability of boys and girls to read on the grade level to which they are assigned. As a result, these students are not able to respond to the traditional written tests which are almost always the only means of evaluation used by teachers.

It is theorized that these students do learn at least some of the basic concepts which are developed through the use of such tools as experiments, demonstrations, films, and field trips. The primary purpose of this study is to devise a method or methods of oral testing whereby learning may be evaluated without the necessity of reading.

Sixteen students, eight classified as readers and eight as non-readers, were involved. The lessons were taught by one student teacher and three other students who were in the elementary science methods course at the University of South Alabama. Emphasis was upon the use of pictures, models, demonstrations, and discussion. No reading was required of the sixteen students.

At the end of the unit the teachers conducted the testing. Each child was given a written test. Then each child was tested orally, using a one-to-one correspondence, one teacher per child. The questions and answers were recorded on tape. The children were permitted to draw pictures to help in explaining their answers. Later the tapes were carefully analyzed and each child's responses were evaluated.

The results of a t-test indicated a significant difference in the scores on the written and oral tests. This was true of both readers and non-readers.

This is part of a study funded by the University of South Alabama. It will be continued, involving students in at least two other grades. Another group of university students will be doing both teaching and testing.

KINESTASIS AND CHRONOCOMPRESSSION AS TECHNIQUES IN SCIENCE TEACHING

Dutchie Riggsby
Auburn University, Auburn, Alabama

Photography, in a variety of forms, has become an accepted part of science teaching. Two relatively new photographic techniques, kinestasis and chronocompression, are being extensively used in commercial motion picture photography. *Kinestasis* refers to a series of rapidly flashing pictures which are arranged in any desired sequence to establish

Abstracts

an effect or impression. The segments of film used in kinestasis endure for three or four frames at a projection speed of 18 frames per second. *Chronocompression* is a fixed sequential presentation of information which is compressed in time. It is used in instances where the sequences of events need to be presented in chronological order, but in less time than their actual normal duration.

These techniques are means for stimulating the student's imagination and for capturing attention. They may be used as: (1) an introduction or overview, (2) an approach to teaching optics and physics, (3) a review of material previously studied, (4) single concept teaching approaches, and (5) impression creating devices.

THE IN-DEPTH TOPIC: RESEARCH FOR ELEMENTARY SCHOOL SCIENCE

Ernest D. Riggsby
Columbus College, Columbus, Georgia

In order to provide students with an opportunity to study a selected subject (topic) with considerably more depth than breadth, the in-depth topic was devised. For a period of 6 weeks, the in-depth topic constituted the main area of interest and study in science. It, moreover, functioned as a central theme for study in social studies, language arts, and creative writing, and as a supplementary source in mathematics.

This paper reports the results of a pilot study and concurrent implementation. The pilot study was carried out with a class of 20 students in a Science for the Elementary Teacher course; the implementation was brought about in an elementary school class.

SOCIAL SCIENCES

OCCUPATIONAL WORK STRUCTURES, OCCUPATIONAL VALUES, AND USE OF LEISURE

Murray Adams
Department of Sociology
Auburn University, Auburn, Alabama

With a growing concern over increasing blocks of leisure time, the research from which this paper originates attempts to explain some leisure differences in terms of variation in occupational subject matter and associated values among academicians. This presentation focuses on the theoretical and methodological difficulties encountered in constructing a model of causation. Some of the problems cited include the difficulty in defining work, leisure, and values; the many sources of variation when considering academicians; and the pitfalls in attempting to construct a typology of value orientations. Various definitions of value are considered, and value is defined in terms of preference. Occupation was chosen as a variable since it is more manageable than the concept, work. Variations in values among academicians are discussed in terms of variations within and between disciplines, the university setting, and the unique values the individual has.

DOWN-TOWN CHURCH IN SOCIAL CHANGE

Harry E. Dickinson
Samford University, Birmingham

The recent division of membership in an all-white down-town church located in a southern metropolis where a Negro woman and her daughter applied for membership affords a "laboratory situation" in which important observations may be made regarding the characteristics of those who took sides in the controversy, and also of those who remained neutral. Members of the church were classified according to the census tracts in which they lived, and when the membership of the down-town church was compared with the membership of suburban churches of similar size, empirical evidence revealed that the down-town church was much more heterogeneous. After the division, the opposing sides were compared according to census tract location, to test the hypothesis that heterogeneity would be reduced on the assumption that some residential locations would show more resistance to integration than others. Empirical evidence relating to the hypothesis was available for place of residence, proximity to Negro neighbors, educational achievement, family income, and age. The hypothesis was supported only by the factor of age. The significance of the incidence for the community's pattern of segregation is discussed in the paper.

THE ENVIRONMENTAL CRISIS IN SOCIOLOGICAL PERSPECTIVE

John E. Dunkelberger
Department of Agricultural Economics and Rural Sociology
Auburn University, Auburn, Alabama

Man's relations with the physical environment have reached crisis proportions in the minds of a growing number of people. From a sociological perspective it appears that the eventual creation of a more compatible relationship between man and environment must come about through fundamental changes in the system of social values. Laissez-faire economic orientations and a view of nature as something to be exploited for profit must be replaced by a sense of moral commitment to the preservation of environmental quality.

In this paper it is contended that population density and increasing pollution, combined with advances in science and technology, have made alternative courses of action both necessary and possible. Men from the poorest to the most wealthy, whether making personal or corporate decisions, must come to consider a sense of moral responsibility to the environment rather than mere convenience or economic expedience in their decision-making.

Consideration is given to the process by which new moral norms tend to be established within society and to how this might occur relative to the environment. It is argued that a social value making individuals morally responsible for the negative consequences of their decisions upon the environment must be created. Law can be used to create public awareness and to motivate the formation of new social values, but legal sanctions alone will not lead to a cultural commitment for the wise use and appreciation of the physical environment.

Abstracts

CHILE: THE FAILURE OF THE MIDDLE CLASS

Elizabeth Gardner
Auburn University, Auburn, Alabama

This paper attempts to ascertain the validity of the traditional hypothesis about the role of the middle class in modernization. It is concluded that the Chilean middle class, although once truly progressive, lost the reigns of leadership as a result of factors arising from (1) its peculiar value structure, (2) the cultural and time context in which it arose, (3) its myopic pursuit of immediate self-aggrandizement when in power, and (4) failure to continue the modernization process it began. Thus, were created the bases for the ballot box Marxist victory of 1970.

PATTERNS OF RELIGIOUS AND POLITICAL INVOLVEMENT: THEORETICAL IMPLICATIONS FROM MAX WEBER

Catherine T. Harris
Department of Sociology
Auburn University, Auburn, Alabama

Following Max Weber's analysis of the relationship between religion and stratification in *The Sociology of Religion*, a multidimensional variable is conceptualized. Based on Weber's principles, this multidimensional variable termed "integration into society" is analyzed as an independent variable influencing the development of certain patterns of religious and political involvement. Integration into society is conceptualized in terms of a cognitive dimension, including the individual's orientation to the value system and his perception of the relevancy of the norms to his own situation, and a structural dimension, which involves the individual's status ranking as well as the stability of his position. This multidimensional variable has to do with the degree an individual "fits" into society and his reaction to this "fit". The following hypotheses are suggested: The highest and lowest degrees of integration will be related to an indifference to traditional organized religion. The highest and lowest degrees of integration will be related to an involvement with "radical" politics. In the middle ranges of the continuum of integration-nonintegration, some degree of involvement with traditional organized religion will be present. In the middle ranges of the continuum of integration-nonintegration, the more integrated will have a churchlike religious preference, while the less integrated will have a sectlike-religious preference. In the middle ranges of the continuum of integration-nonintegration, the more integrated will be oriented to "liberal politics". The less integrated will be oriented to "conservative politics". At the present time, a first test of these hypotheses is being carried out.

VALUE: A SOCIOLOGICAL CONCEPT RECONSIDERED

Chester W. Hartwig
Department of Sociology
Auburn University, Auburn, Alabama

Max Weber pointed out, years ago, that there develop cultural periods where the problems of the time generate new perspectives which have their impact on science in modifying both its procedures and views. It might be well to ask as to whether we live in such a period. The various protesting groups, particularly the youth groups in our several social sciences, may be responding to such a cultural period when they evince their doubts and disturbance with the character of the sciences to which they are being introduced or with which they have contact. A basic difficulty of present-day science may be its inadequate conceptualization of the nature of value and, hence, a failure to understand the significance of value in shaping our scientific work.

PEACE IN THE MIDDLE EAST

T. Kermani
Youngstown State University
Youngstown, Ohio

No one seems to be anxious for peace in the Middle East except the United States. Only through peace, can we hope to cover up our past errors and end our commitments, honorably.

Neither Arabs, Israel, nor the Soviet Union want peace on our terms. Arabs believe time itself is on their side. Israel has given too much to accept peace for other's convenience. They want peace only if it is a lasting one. The Soviet Union can further expand her influence in the area through the existing warfare.

The solution must be sought with this fact in mind; there can be no fruitful peace negotiation as long as Israel occupies some Arab territory. Israel's offer to purchase these lands can pave the way for peace negotiation. In the long-run, however, Israel must try to blend in with her Arab neighbours, live among her semetic brothers as one of them -- though following a different faith like Lebanon -- rather than a "front line for Western defense in the Middle East."

GOVERNORS, POLITICIANS, AND THE SOURCES OF INSTABILITY
IN THE COLONIES: NEW JERSEY AS A TEST CASE

John R. McCreary
Columbus College, Columbus, Georgia

The great diversity of the proprietary and religious groups which were brought together in 1702 under royal government made for confusions and antagonisms in New Jersey, and it is within this context that the colony's politics must be examined. The political factions spawned by social and economic mobility and a mania for public office so typical of colonial America greatly enhanced the inherent instability of politics

Abstracts

and society in New Jersey, and made conflict inevitable. The situation was further confused by the division of authority between local and imperial government which so indelibly marked the conduct of imperial politics and administration. Dissident politicians sought personal influence through the assembly, which they could in turn use against the royal administrator to demand favor and place. Such men left no avenues to power unexplored, and in the process exploited the division between the governor's local influence and the ultimate authority at Whitehall.

The governor's position was thereby rendered exceedingly vulnerable, for he had at once to satisfy imperial administrators and his supporters in the colony, while simultaneously guarding against the possibility of ministerial shifts in London and the efforts of rivals eager for preferment. This was more significant in the period prior to 1730, when little stability existed in English ministries. The governors were ordinarily retainers of "great men" in England, and their appointments were secure only as long as their service was satisfactory and their patrons remained influential. Thus Edward, Lord Cornbury, was in no danger of being replaced until the decline in influence of his uncle and father. Once such support in the home government had failed, however, the governor became vulnerable to both local and imperial pressures, and the impact of factional opposition became more significant.

Most governors based their pretensions on influential men, but equally significant was the composition of the administrative boards, particularly the Commissioners of Trade and Plantations. Also important, at least until 1720, was the interaction between religion and politics, as colonial factions sought to exploit ties within the religious establishment in England in order to secure support for their respective positions.

It was within this framework that colonial politics were conducted in the early eighteenth century. Power was diffused and uncertain until about 1730, when the Duke of Newcastle's hold on colonial patronage considerably altered the situation. During the first 30 years of the eighteenth century, however, when ministries in Britain rose and fell, sometimes in rapid succession, the politics in the colony were considerably more volatile. This article has examined both the local wranglings which typified the colony's politics and the realities of imperial connection, and in the process has demonstrated that despite a plethora of local issues and personal antagonisms the political history of New Jersey was in reality inextricably tied to the seat of ultimate authority in the English colonial world--to Whitehall and the administrators and politicians who ultimately controlled the outcome of major political events in the colony.

THE ALABAMA FREEDMEN AND THE ECONOMIC ADJUSTMENTS DURING PRESIDENTIAL RECONSTRUCTION, 1865-1867

John B. Myers
Columbus College, Columbus, Georgia

The conclusion of the Civil War resulted in the actual emancipation of approximately 439,000 former Alabama slaves. Alabama's human and economic resources were depleted and the government on the state and local level was virtually non-functional. The problems of former Alabama slaves in adjusting to their freedom were complicated by a general lack

of economic security in the form of jobs, land, finances, and necessities of life.

The economic plight of the freedmen was met by the Federal government with the creation of the Freedmen's Bureau on March 3, 1865. The Bureau appointed assistant commissioners who were to administer the issuance of food, clothing, temporary shelter, and medical attention for suffering freedmen and white refugees. The most pressing task facing Assistant Commissioner Wager Swayne was the issuance of food rations to the starving and indigent Alabamians. From November, 1865, to October, 1866, the Freedmen's Bureau issued a total of 3,789,788 rations to approximately 166,589 whites and 72,115 blacks in Alabama.

Freedmen who were without shelter and employment were gathered into temporary Bureau colonies until they could be rehabilitated and relocated. The centrally located colonies provided aid to the indigent, sick, and aged of both races. In order to care for the sick, the Freedmen's Bureau established hospitals in seven major Alabama towns which treated approximately 9,859 freedmen and 473 whites from September, 1865 to 1867.

One of the more urgent Alabama problems of the time was the labor supply. The abolishment of Negro slavery necessitated the creation of a revised labor system. White Alabamians' attitude toward a free black labor system ranged from abject pessimism to guarded optimism. By restoring a compatible and prosperous relationship between capital and labor, the Freedmen's Bureau hoped to enhance the blacks' economic status and hasten their integration into a free society. Assistant commissioners were authorized to introduce practical systems of labor, issue contract regulations, and resolve differences arising between whites and blacks. Alabama's general poverty increased the difficulty of adjusting to a free black labor system. The lack of capital necessitated the adoption of the share-crop system. In certain instances this system led to a type of peonage which kept the freedmen in debt and bound to the land. Evidence indicated that the freedmen's general response to work in 1866 was commendable. Reports from various Alabama counties and towns concurred that freedmen made contracts and went to work.

The thought of free black labor was repulsive to some whites who refused to hire freedmen and instead sought Chinese and German immigrant labor. There were few examples of planters successfully utilizing white immigrant labor which ultimately resulted in the acceptance of the freedmen's labor.

Other measures enacted by the Federal government and the Freedmen's Bureau attempted to insure the freedmen more permanent economic security. One aim of the Homestead Act of 1866 was to afford the blacks the opportunity to become freeholders. In Alabama the act was generally a failure. Inadequate finances prevented most blacks from securing the equipment necessary to maintain a homestead.

Precautions had been taken to cope with the freedmen's inadequate financial backing through the passage of the Freedmen's Bank Act of March, 1865. Branch banks of the Freedmen's Savings Banks were established in Huntsville in 1865 and Mobile in 1866. The blacks in Alabama who were aware of and in proximity to the institutions welcomed them. Freedmen in far-removed areas received little benefit.

By 1867 the economic status of the Alabama freedmen had been altered considerably. The Freedmen's Bureau provided initial assistance for survival. Freedmen had demonstrated an apparent reliability as free laborers. The Homestead Act and Freedmen's Bank Act fell short of the intended

Abstracts

goals but did provide for black self-sufficiency on a limited basis. Obviously the Alabama freedmen needed sincere and sustained assistance to complete the economic transition from slavery to freedom.

SOME FRENCH VIEWS OF ANTE-BELLUM ALABAMA

Bernerd C. Weber
History Department
University of Alabama, University

Many educated foreigners were attracted to the Deep South and to the state of Alabama in the ante-bellum period, and France was not the least of Western European powers whose inhabitants found their way to this area. Some of these travellers have written interesting and valuable accounts of their impressions of this state. Among the more notable French visitors of this period may be mentioned the Marquis de La Fayette and his secretary Auguste Levasseur, the author Charles Olliffe, the educator and regicide Joseph Lakanal, and the distinguished naturalist Francis, the Count de Castelnau. Although accounts of their travels may vary considerably in length and in the depth of their perception they all possess the saving merit that their eyes directed their pens. French travellers tended to give careful attention to the economic and social aspects of life in ante-bellum Alabama for these facets of existence in a frontier state were matters of great interest.

Perhaps the chief value to the modern historian of these early travel accounts is in the contemporary observations of the authors. They have the added value of exhibiting the probable impressions that French readers received about Alabama in particular and about the Deep South in general.

CHANGING PATTERNS IN MARRIAGE AND DIVORCE IN ALABAMA FROM 1958 TO 1968

Henry E. White, Jr.
Samford University, Birmingham, Alabama

Changes in marriage and divorce patterns are observable in Alabama during the 10 year period 1958 to 1968. The data which indicate these changes are supplied by the Bureau of Vital Statistics, Montgomery, Alabama. Percentages of marriage and divorce characteristics for 1968 are compared with percentages for 1958. These data show that there has been change in the rate of marriage, the month in which most weddings were performed, and the rate of young marriages. Divorce changes which are indicated are as follows: the rate of divorce, the month in which most divorces were granted, the length of divorced marriages, grounds used for securing a divorce, the number of divorces including children, and the number of divorces granted to women.

ENGINEERING

FAULT DETECTION IN DIGITAL CIRCUITS

B. D. Carroll

Department of Electrical Engineering
Auburn University, Auburn, Alabama

This paper describes two methods of generating tests for the detection of faults in combinational logic circuits. The detection of faults in a digital logic circuit can be accomplished by applying a sequence of test inputs to the circuit and observing the resulting sequence of circuit output responses. An exhaustive test is usually impossible. Hence the design of a fault detection experiment for a given logic circuit consists of the determination of an efficient set of test inputs and the corresponding outputs of a fault free circuit.

Two methods for generating test inputs, the two dimensional path sensitizing method and the Boolean difference method, are described. Both methods assume that the logic function describing the network to be tested and the network topology are known.

LONG-TERM EFFECTS OF GRAVITY-GRADIENT TORQUE ON THE ROTATIONAL MOTION OF A TRIAXIAL ARTIFICIAL EARTH SATELLITE

J. E. Cochran

Department of Aerospace Engineering
Auburn University, Auburn, Alabama

A method of general perturbations, based on the use of Lie series to generate approximate canonical transformations, is applied to study the effects of gravity-gradient torque on the rotational motion of a triaxial, rigid satellite. The center of mass of the satellite is constrained to move in a precessing, constant inclination, Keplerian elliptic orbit about an attracting point mass. The method of general perturbations is used to obtain the Hamiltonian for the nonresonant secular and long-period rotational motion of the satellite to second order in $\frac{\eta}{\omega_0}$, where η is the orbital mean motion of the satellite's center of mass and ω_0 is a reference value of the magnitude of the satellite's rotational angular velocity. The differential equations derivable from the transformed Hamiltonian are integrable in terms of elliptic integrals and Jacobian elliptic functions. Geometrical aspects of the long-term rotational motion are discussed and a comparison of theoretical results with observations is made.

Abstracts

PRELIMINARY DESIGN REQUIREMENTS FOR ORBITAL SPACE STATIONS -- THE APPLICATION OF A COMPUTER SIMULATION MODEL

S. W. Demster and G. W. French
The Boeing Company, Aerospace Group
Huntsville, Alabama

This paper presents a computer simulation technique for determining preliminary design requirements for orbital space stations from the scientific/technology objectives (experiments) of the mission.

The model operates on users supplied data such as experiment I.D. number, number of repetitions for each experiment, experiment duration, and a listing of incompatible experiments, i.e., those which must not be scheduled simultaneously. If any experiments require line of sight with celestial targets these stellar coordinates of these targets are input to an ephemeris generator module.

From these data the model randomly constructs large numbers of schedules on which to perform statistical analysis. From these schedules and the input resource characteristics of each experiment, e.g., electrical power, astronaut requirements, output data rate, weight and volume, the model prepares a series of mission experiment resource profiles for analysis using statistical techniques.

FRACTURE STRENGTH OF CERAMIC MATERIALS UNDER COMBINED STRESSES

Richard E. Ely
U. S. Army Missile Command
Huntsville, Alabama

The fracture strength of titania was determined under tension-tension and tension-compression stresses at room temperature. Thin-walled tubes were fractured using various combinations of internal fluid pressure and axial loads. The results are predicted best by failure theories based upon an energy criterion. Background information includes a discussion of proposed failure theories for brittle materials and a review of related experimental work.

EARTH ORBITAL EPHEMERIS GENERATOR FOR PRELIMINARY DESIGN APPLICATIONS -- AN APPROXIMATION TECHNIQUE

G. W. French and S. W. Demster
The Boeing Company, Aerospace Group
Huntsville, Alabama

This paper presents a technique for calculating Earth orbit occultation ephemeris data. An algorithm is developed using problem geometry and orbital mechanics to present the user with a means to determine occultation periods of celestial targets as viewed from an orbiting space station. The data obtained from sample problem computations has given the occultation periods within 2 minutes of the periods calculated by much more sophisticated techniques, e.g., Samson Ephemeris Generator. The technique is easily adapted to small calculator/computers and there-

fore provides the user with readily available, low cost data for preliminary design application.

C-BAND REACTIVE STRIPLINE POWER DIVIDER

William C. Holt, J. M. Loomis, III, and E. R. Graf
Department of Electrical Engineering
Auburn University, Auburn, Alabama

A design of a co-phased, equi-amplitude, 16-way, planar power divider in stripline is developed. The design of two-way power dividers and bends in stripline is also presented. The power divider has the following capabilities: frequency range of 5.25 to 5.75 GHz, VSWR less than 1.3:1, output amplitude between ports of ± 0.5 dB, output phase difference between ports of less than ± 6.0 degrees, and isolation between ports of 40 dB.

A MINICOMPUTER SYSTEM FOR EDUCATIONAL PURPOSES

Thurman A. Irving, Jr. and H. Troy Nagle, Jr.
Department of Electrical Engineering
Auburn University, Auburn, Alabama

In this paper a minicomputer system is proposed to be used as a teaching aid in certain undergraduate and graduate level Electrical Engineering courses. The need for a general purpose digital computer is discussed and specific courses where it may be used are presented. The desirable characteristics of a computer system to fit this need are next discussed. Finally, certain specific hardware and software features of the proposed minicomputer are presented.

WIND TUNNEL STUDIES OF AERODYNAMIC INTERACTION BETWEEN C.O.E. TRUCKS AND CARS

Joseph E. Johnson and Kynric M. Pell
Department of Aerospace Engineering
Auburn University, Auburn, Alabama

Pressure distributions, side force coefficients, drag coefficients, and moment coefficients were measured on a 1/24 scale model of an intermediate sized sedan located in proximity to the tractor of a 1/24 scale cab-over-engine tractor/trailer combination. Tests were conducted at a Reynold's number of 4.5×10^5 so that the results may not be free from Reynold's number effects. Flow separation was found to occur over the forward regions on the sides of the tractor. Maximum side forces and moments occurred when the car was slightly ahead of the truck and at a critical spacing. Based on the coefficients determined a full-scale vehicle operating at 60 mph could experience peak forces in excess of 160 lb and simultaneously a moment of 2000 ft-lb.

The addition of turning vanes to the forward corners of the tractor controlled the separation and reduced all coefficients to reasonable values.

Abstracts

METEOR TRAIL RADIATION

T. Dwayne McCay and Kenneth E. Harwell
Department of Aerospace Engineering
Auburn University, Auburn, Alabama

The natural phenomenon of a meteor entering the earth's atmosphere is accompanied by a release of observable electromagnetic radiation. This radiation has its origin in the envelope of high temperature gas produced about the meteor due to collisions with the air molecules. Spectroscopic observations of artificial meteors have indicated that the radiation is from excited atoms of the meteor itself and not from the surrounding air atoms. This paper is concerned with a numerical method of predicting the optical radiation from an artificial or natural meteor. The three areas of the problem which are discussed are heating and vaporization of the solid meteor, formation of the metallic gas cloud, and calculation of the atomic radiation from that cloud.

SPACE STATION EXPERIMENTS

Ronald I. Miller
The Boeing Company
Huntsville, Alabama

A data base of resource requirements for Space Station scientific experiments has been constructed including experiment requirements for electric power, astronaut time and skill, data rate, weight, and volume. Power, astronaut time, and data rate are given as functions of time. The data base was originally intended to be used as a guide in the development of a preliminary design computer model of space missions, but other uses were subsequently discovered.

The NASA document "Candidate Experiment Program for Manned Space Stations," commonly called the "Blue Book", was the primary reference used in construction of the data base. The contents and organization of both the "Blue Book" and the Boeing data base are outlined. A summary of Space Station experiment parameters is presented, and experiment groups placing the most severe requirements on the Station are identified. Current efforts in the areas of "Blue Book" experiment definition and preparation of specific experiment groups for Space Station flights are discussed.

COMPUTER-AIDED DIGITAL FILTER DESIGN

H. Troy Nagle, Jr. and Ronald White
Department of Electrical Engineering
Auburn University, Auburn, Alabama

This paper presents 11 digital filter programming forms which have been incorporated into a high-speed stored-program special-purpose computer design. Filter output errors due to quantization effects are analyzed using three techniques: statistical analysis, steady-state analysis, and upper bound analysis. Using the statistical method, a Filter

Implementation Program in Fortran IV is used to select the filter programming form with the least mean-squared error. The results are presented for two digital filter transfer functions, $D(z)$. (This work was supported by the National Aeronautics and Space Administration under NAS8-20163.)

AN EVALUATION OF TOUGHNESS OF HEAT TREATED ALLOY STEELS
BASED UPON ENERGY DISSIPATION

E. J. Planz
University of Alabama, University

An instrumented impact machine was utilized to evaluate the toughness of materials both as received and in the heat treated condition. A correlation existed between portions of the oscilloscope traces obtained from Charpy v-notched impact specimens and standard tensile threaded specimens with regard to mechanical properties such as ultimate tensile load and % elongation in 1 inch. In addition, with an additional modification of the instrumented impact machine a correlation was shown to exist between the oscilloscope traces of v-notched tensile impact specimens and v-notched tensile threaded specimens with regard to ultimate tensile loads.

The time response to fracture of ferrous materials should be included in evaluating the toughness of materials and should be considered before recommending ferrous materials for critical utilization. As an alternative one may employ the complete stress-strain curve.

SELECTION OF OPTIMUM COTTON HARVESTING CAPACITY
USING AN INVENTORY MODEL

Donald Wayne Sanders and William F. Lalor
Department of Agricultural Engineering
Auburn University, Auburn, Alabama

Due to increased labor shortage, rising costs of production, and the uncertainty of government cotton programs, farmers are faced with the need to make more effective use of their crop-production equipment. The equipment needed for some operations such as harvesting is of a specialized nature and its use is independent of other machinery and equipment used in crop production. Optimizing the selection of such specialized equipment can often be accomplished effectively by the use of certain management techniques already available. An inventory-optimization model is presented and modified for application to the problem of optimizing the selection of cotton-harvesting machinery.

By using the modified model, it is possible to minimize the total expected cotton-harvesting costs over the long run. The model permits determination of the optimum harvesting capacity by minimizing the sum of the costs of having too much capacity in good harvesting weather and of not having enough capacity in poor harvesting weather. The conditions under which the cost function is minimized are established and shown to depend on a knowledge of a probability function $P(r)$ dependent on weather conditions. The probability function indicates the probability of r

Abstracts

acres/hour harvesting capacity being required to complete A acres of harvest in a given time period.

A probability model for hours available for harvesting cotton is developed from 31 years of temperature and relative-humidity data collected at Maxwell AFB, Montgomery, Alabama. The criterion for determining the suitability of an hour for harvesting is the seed-cotton moisture content on the stalk. This is calculated by using relative humidity and temperature in an equilibrium-moisture equation. The function $P(r)$ is then identified.

The optimization model is solved and the results are presented in easily usable graphical form for a range of farm and price conditions.

CHARACTERISTICS OF UMBRELLA ANTENNAS -- A METHOD OF MOMENTS SOLUTION

C. E. Smith and R. F. Blackburn
Electrical Engineering Department
University of Mississippi, University

Umbrella antenna configurations are used to top-load electrically short monopole antennas to increase effective height for larger efficiency and/or to increase antenna capacitance for minimum tuning requirements. The basic performance of umbrella type structures has been investigated. However, general design data for this type umbrella antenna have not been available until recently in the form of published design nomograms for capacitance and effective height based on computer computation for small rib diameters.

The static capacitance of a variation of an umbrella antenna which employs multiple-wire rib construction has recently been reported. This multiple-wire rib configuration is employed to increase the effective rib diameter and, thus, to obtain a larger total antenna surface and capacitance with a negligible decrease in antenna effective height. (See Smith and Graf., J. Ala. Aca. Sci. Vol. 39, No. 3, p. 247-48, July 1968).

In this paper the computation of the static capacitance and effective height of a single-wire rib umbrella antenna is discussed in terms of a numerical solution of the integral equation of the static potential of the structure for several values of antenna height, and rib radius, length, and angle with respect to the vertical radiator. This solution technique is the method of moments as formulated by Harrington. This study, which presents results for large rib diameters not presented previously, is an extension of the work of Smith and Graf.

As a beginning to the study of such structures, consider the calculation of the charge density distribution on an umbrella antenna structure consisting of infinitely thin wires at a potential V above a perfectly conducting ground plate. If image theory is used, the problem can be reduced to the solution of the charge density for the wire structure and its image.

For the region of interest, the solution of Poisson's equation for potential subject to boundary conditions yields the familiar expression

$$\phi(\underline{r}) = \int_V (\rho(\underline{r}') / (4\pi\epsilon |\underline{r} - \underline{r}'|)) dv' \quad (1)$$

or, in operator notation, $\phi = L\rho$,

where

$$L = \int_V \rho \, dv' / (4\pi\epsilon |\underline{r} - \underline{r}'|)$$

which has a domain consisting of all functions ρ which correspond to the existing boundary conditions.

The problem to be treated can be stated as: solve for the charge density distribution along a thin wire umbrella antenna through the use of the method of moments. Once the charge density is known, then related field quantities such as charge distribution and capacitance can be determined. The moment method formulation, which is a unified approach for computing solutions to field problems with matrix methods, can be briefly divided into four basic steps: (1) Expansion of the unknown in terms of a set of basis vectors spanning the domain of the operator, (2) Definition of a set of testing vectors and determination of a suitable scalar or inner product, (3) Computation of the matrix coefficients and formulation of the matrix equation from the scalar product, and (4) Solution of the matrix equation for the unknown coefficients of the basis vectors. For the formulation of this problem using the moment technique, a subsectional basis vector of the delta function form, $\delta(\underline{r}' - \underline{r}_n)$, is employed for the representation of the unknown charge density along with a point matching approach, $\underline{w}_m = \delta(\underline{r} - \underline{r}_m)$, for the solution of (2). This particular combination of testing and basis vectors is very convenient in the solution of (2) because it minimizes the computation required in formalizing the problem in terms of a matrix solution.

A suitable scalar product for this problem over all space is

$$\langle \underline{f}, \underline{g} \rangle = \int_V wfg \, dv \quad (2)$$

where $w > 0$ is an arbitrary weighting function which is assumed constant in this case. If this scalar product and appropriate expansion function are employed, the matrix formulation of the problem becomes

$$\sum_n^N a_n \langle L\rho_n, \underline{w}_m \rangle = \langle \underline{\phi}, \underline{w}_m \rangle \quad (3)$$

If we now take N equations of the form of (3) for m equal to N test points, then the problem can be formalized in a matrix form of $[\ell_{mn}] \times [Q_n] = [V]$ where $Q_n = w a_n$ which is the total effective charge on an equivalent line segment if w is the segment length.

A computer program has been developed for the numerical computation of the reduced matrix formulation using a cylindrical shell model of the rib for the ℓ_{mn} coefficients. Numerical results for the static capacitance and effective height for the antenna have been computed and compared with related data computed for a similar single-wire rib umbrella antenna. Experimental results for a 200:1 scale model study of this type antenna structure has shown very close agreement between actual and computed values of capacitance. (This work was supported in part by a University of Mississippi Faculty Research Grant and a National Science Foundation Departmental Science Development Grant, GU 3833.)

Abstracts

AN ENGINEERING APPROACH TO MODELING BIOLOGICAL SYSTEMS

Joseph W. Stanfield and Kynric M. Pell
Department of Aerospace Engineering
Auburn University, Auburn, Alabama

The gross, microscopic, and submicroscopic viscoelastic properties of human skeletal muscle are summarized. These properties are modelled at the sarcomere level by a mechanical system consisting of a dash pot of variable damping coefficient, an elastic rod having a variable elasticity, and an elastic rod of constant elasticity. The properties of these elements are obtained from an analysis of the contraction process at the submicroscopic myofilament level. A muscle fiber is considered as a homogeneous medium composed of infinitesimal elements exhibiting the viscoelastic properties of the model. A simplified equation of motion is obtained for a muscle fiber which displaces a mass consistent with physiological requirements. The system is simulated using an analog computer and its behavior shows good qualitative agreement with physiological data. The existence of a displacement function, a leading and lagging effect due to flow of an activating substance, and a transfer function relating stimulation frequency and muscle response is indicated.

AERODYNAMIC FORCES ON SURFACE TRANSPORTATION VEHICLES

Charlie D. Turner and Donald C. Raney
University of Alabama, University

The design of a fixed groundplane system with an adjustable flap is given for the University of Alabama subsonic wind tunnel. The subsonic wind tunnel and groundplane system are used to determine the steady state aerodynamic forces and moments on a tractor-mobile home combination. Analytical equations are presented for the dynamics of the tractor-mobile home, in terms of the steady state aerodynamic coefficients. Future work will include a computer simulation of the dynamics of the tractor-mobile home combination to determine the optimum tractor-mobile home configuration for highway operation.

OPTICAL COMMUNICATIONS FOR SPACE APPLICATIONS

Glenn Weathers and Grady Saunders
Sperry Rand Corporation, Space Support Division
Huntsville, Alabama and
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

The development of reliable coherent optical sources has been the impetus for research in the area of optical communications. This paper investigates developments in optical communications with emphasis upon space applications. The primary reason for the investigation is the expected future communications requirements of the space program. Transmission of information from deep space probes at high rates will require capabilities beyond those of the traditional microwave system. The

investigation includes a review of the current state-of-the-art of optical components, along with an analysis of several characteristics of the space channel. Several aspects of optical space communications that need further study are identified in the conclusion.

DIGITAL FILTER IMPLEMENTATIONS

Ronald White and H. Troy Nagle, Jr.
Department of Electrical Engineering
Auburn University, Auburn, Alabama

In this paper several hardware implementations of sampled-data control system compensators (digital filters) are presented. A hybrid implementation which uses digital elements for time delay and analog elements for multiplication and summation is described. A special-purpose digital computer with a hardwired control unit is also illustrated. Subsequently, a technique called "range switching" is introduced for the special-purpose computer. The final implementation is a high-speed stored-program special-purpose computer which employs a hardwired multiplication network. (This work was supported by the National Aeronautics and Space Administration under NAS8-20163.)

THERMAL POLLUTION NEAR THE JUNCTION OF TWO CONFLUENT STREAMS

Cheng-Hsien Yuan, B. F. Barfield, and C. K. Liu
University of Alabama, University

A simple model has been proposed to analyze quantitatively the thermal pollution in the mixing region of a river and its tributaries of higher temperature. Assuming that the hydrodynamic mixing precedes long before the thermal mixing, the steady-state temperature distribution in the mixing region can be computed from a simplified energy equation. The computerized solution of this equation shows that the maximum temperature in the river after mixing drifts toward the center line as the distance from the junction becomes larger. As expected, the magnitude of the maximum temperature decreases, and the distance required for a fixed percentage of reduction of the maximum temperature increases at stations farther away from the junction.

From the results of this investigation, for the case: $R_e = 10^5$, it is possible to deduce that

$$\frac{L_{50}}{W} = 86.7\beta - 1.8$$

where L_{50} is the distance required for a 50% reduction of the maximum temperature, W is the half-width of the river, and β is the ratio between the width of the high-temperature stream entering the river and the width of the river.

Abstracts

ANTHROPOLOGY

APPARENT ARCHAIC INFLUENCE SEEN IN AN OTHERWISE PURE BAYOU LA BATRE PHASE SITE IN CLARKE COUNTY, ALABAMA

David W. Chase
Montgomery Museum of Fine Arts
Montgomery, Alabama

A recently explored shell midden containing a pure Bayou La Batre ceramic inventory, located on the left bank of the Tombigbee River near the mouth of Jackson Creek, Clarke County, Alabama, also yielded a number of projectile points of the large stemmed variety most commonly associated with Late Archaic sites in most parts of the state.

Ten of the projectiles were selected from the recovered collection and subjected to definitive comparison with three classical Late Archaic types known best from the Tennessee Valley (Cambron and Hulse, 1964).

The types most similar to those found at the Jackson Creek Site were Pickwick, Ledbetter, and Little Bear Creek. All have origins on pre-ceramic time levels with the Ledbetter and Little Bear Creek types persisting into Early Woodland in northern Alabama. In the study, five of the sample projectiles from Jackson Creek Site showed positive Pickwick definitive relationships and the others related more strongly to either Ledbetter or Little Bear Creek types.

The study strongly suggests interaction between the shell midden Bayou La Batre group and neighboring Archaic peoples either through trade or through individual attempts to imitate lithic products of neighboring Archaic hunters.

EVIDENCE OF PULMONARY OSTEOARTHROPATHY SEEN IN THE REMAINS OF A PREHISTORIC DOG

David W. Chase
Montgomery Museum of Fine Arts
Montgomery, Alabama

Explorations at the Hickory Bend Site in Montgomery County in the autumn of 1967 and spring of 1968 resulted in the recovery of both human and animal remains. Among the latter were found seven buried dogs (*Canis familiaris*). Since the site had several prehistoric components, care was taken to identify each of these animal graves in terms of cultural provenience. It soon became clear that all had belonged to a Late Woodland people whom we have named Hope Hull Phase. This level of occupancy of the site, which took place somewhere between 700 and 900 A.D. (Carbon-14 samples are currently being dated at the time of this writing), involved a large, apparently stockaded village. Of the 29 human burials recovered, half were of the Hope Hull Period.

In cleaning the dog remains, one specimen exhibited unusual bony lesions in the long bones. The phalanges, tibias, fibulas, radii, and ulnas were most extensively involved, and the femurs and humeri to a lesser degree. One pelvis was slightly afflicted.

The remains were taken to a local veterinarian (Montgomery) who

tentatively identified the lesions as being symptomatic of hyperpulmonary osteoarthropathy (HPOA) also called Marie Bamberger's Disease. Beginning in the lungs, the first symptoms appear as a cough or dispea. Associated symptoms involve a proliferation of bony growth in distal elements such as the phalanges. This appears as a osteophytic patina which imparts a very rough surface to the involved bones. Ultimately, the long bones become involved and the pathological picture becomes terminal. Causes of the disease are still being researched; however, a lung parasite is suspected.

Research conducted by the School of Veterinary Medicine at Auburn University has shown that there is a high incidence of HPOA in the east-central to eastern parts of Alabama. The discovery of the buried diseased dog in this same area poses the intriguing possibility of a disease which, due to some ecological factor peculiar to this area, still persists after a thousand years.

JACOB'S SWAMP: AN EARLY ARCHAIC SITE IN AUTAUGA COUNTY, ALABAMA

David W. Chase
Montgomery Museum of Fine Arts
Montgomery, Alabama

The discovery of a large Paleo-Indian site in Autauga County located near the large cut-off or swampy bed of the ancient Alabama River, which today flows a mile to the south, is the first instance of such a find in the upper Alabama Basin recorded to date. Sheet erosion on the site indicated that cultural material was not deep and that artifacts would be confined mainly to the topsoil or plowzone levels, thus precluding interpretive separation. This factor prompted a search in nearby areas for a similar site which would present good conditions for stratigraphic preservation and which also would include the Paleo-Indian component observed at the aforementioned site.

Two sites were selected which appeared to qualify as 'deposition' rather than 'erosion' areas from the geomorphological standpoint, and which also reflected evidence of Indian occupancy in terms of surface artifacts.

The first site, *Au 61*, was located on what had been a sandy knoll, possibly a beach-dune of the ancient river. Tests there were made to a depth of 6 feet. Only in the upper zones were artifacts recovered, and these pertained only to the Late Archaic Stage. A large amount of fiber tempered pottery was recovered from this level, which admittedly enhanced the importance of the site.

The second site, *Au 62*, showed more promise. In the second and third levels of a sand-gravel second stream terrace, we isolated a Big Sandy Component containing type projectiles of the Big Sandy of Kirk Configuration, small flake tools and other stone implements. In Level 5, our lowest zone of exploration, only one projectile was recovered, which displayed the general configuration of the Dalton projectile. Certain of the Big Sandy projectiles found seemed to bear a closer resemblance to the Hardaway type, which in Central Alabama is probably earlier and closer to classical Paleo-Indian artifact ranges.

These site-finds point up the significance of early campsite location along ancient river terraces, which have since been abandoned by the

Abstracts

meandering river and which are represented only as swamp-filled bayous today. Specific efforts to isolate Paleo-Indian and Early Archaic sites must include sub-surface explorations of these fossil benches and terraces, many of which conceal campsite debris reflecting some of the very earliest human activity in central Alabama.

BUGS, BONES, AND ENZYMES: THE STORY OF A FAUNAL COLLECTION

C. B. Curren, Jr.
Department of Anthropology
University of Alabama, University

At the present time, there is a serious need for identification of faunal remains recovered in Archaeological sites. In an attempt to meet this need, the University of Alabama Museums and Department of Anthropology has established a comparative osteological collection of local species. The collection is now aiding in archaeological faunal identification and in the future will expand to meet this growing need that presents itself to the field of Archaeological Research.

MASADA -- WATCHWORD OF A NATION

Nancy Hollis
Samford University
Birmingham, Alabama

One of the most crucial international problems today involves the modern state of Israel, a government set up in 1948, which now holds all the Sinai peninsula, Syria's Golan Heights, and half of Palestine west of the Jordan River. This state represents the only autonomous Jewish state since the Romans devastated Palestine between the years 66 and 73 A.D. This paper, based on my recent visit there, and the study of the book *Masada* by Yigael Yadin, is a report on the last Jewish site taken by the Romans-Masada, its history, archaeology, and significance.

AN EXCAVATION NEAR WILSONVILLE, ALABAMA

Karen Joines
Samford University
Birmingham, Alabama

A class of Samford University students in January 1971 excavated seven burials at a site near Wilsonville, near the Coosa River, reputed to be an Indian cemetery. These burials proved to be in wooden boxes held together by iron nails. They are burials dated probably between 1825 and 1875 and are those of early settlers.

ARCTIC ARCHAEOLOGY AND ITS RELEVANCE IN TERMS OF MAN'S
PREHISTORY IN THE NEW WORLD

Regina J. Kinsaul
University of Alabama, University

The origin of the American Indian has been a major question since their discovery in 1492. It is a generally accepted theory that the first Man to enter the New World came by way of the Bering Land Bridge which existed intermittently during the Pleistocene. The bridge was, at its driest, 1300 miles wide, a vast gently sloping plain covered with tundra type vegetation. The first Man to enter the Americas was a pre-Mongoloid or proto-Mongoloid racial type and a nomadic hunter. He followed his game animals into the New World and eventually dispersed throughout the continents. Although his earliest camps have not been found in the Arctic area, his later habitation areas have. They have discovered six distinct pre-Eskimo traditions dating from 20,000 B.C. to 1,000 B.C. The Eskimo tradition is divided into four subdivisions dating from 1,000 B.C. to 1,000-2,000 A.D. Their sites were restricted to the coastal areas and they were dependent on sea mammal hunting. Therefore, a study of Arctic Archaeology records Man's entry and spread throughout the New World and the cultural changes he underwent.

RELATIONSHIPS BETWEEN BODY BUILD AND BODY-IMAGE OF
PARENTS AND CHILDREN

Susan Merkel and Helen Douty
School of Home Economics
Auburn University, Auburn, Alabama

A background explanation of the development of the graphic somatometry method and its application in research studies conducted at Auburn University was presented. This method provides a procedure for viewing the human body allowing one to obtain detailed information on the nature, shape, and size of the body. An explanation of the photographic system called graphic somatometry was presented as an introduction for the specific study of parents and children.

Relationships of posture patterns, body build, and body type between children and parents were investigated by analyzing somatographs of 33 families. Postural variances of a child were compared with those of his parents. The child's body-image was derived from a somatograph choice list and compared to the parental attitudes of the child's body which consisted of an average score taken from a body-cathexis check list.

A definite trend was found between children and their parents when comparing their body build and a significant relationship between a child's body type and the body type of one of his parents. A definite, but not significant, relationship was found between the postural variances exhibited by the parents and those present in the small child. A high occurrence of postural variances among all subjects was found in this study.

The results from relating the child's body-image to the parents' attitudes toward the child's body indicate a positive relationship with the mother's attitude and a significant negative relationship with the attitude expressed by the father.

Abstracts

The children were able to select their own photographs 65.7 per cent of the time, which indicated they could identify with their own bodies as well as select them from an assembly of other photographs.

THE MARKET OF TICUL, YUCATAN: SOME ANTHROPOLOGICAL ASPECTS

Paul H. Nesbitt
University of Alabama, University

During June and July, 1970, the Department of Anthropology, University of Alabama, conducted an interdisciplinary study of selected rural markets in the vicinity of Ticul, Yucatan. Three faculty members and nine students participated in the project.

Ticul is a predominately rural area and the market serves as a principal means for the flow of produce and commodities, and also plays a major role in socially integrating the predominately Maya-speaking communities.

Some preliminary findings are reported. Among these are: (1) the structural and administrative organization of the Ticul market, (2) market strategy and coalitions, (3) specialization and socialization in market activities, (4) male and female roles, and (5) identification and provenience of market products.

TICUL, YUCATAN, MEXICO AND NORTHPORT, ALABAMA -- SOME PARALLELISMS IN RURAL MARKETS

Lois Bartelme
University of Alabama, University

It is suggested that the markets in Ticul and Northport are similar enough to be classified as the same type, i.e., Manning Nash's classification of adjunct export markets. The two markets evidence likenesses in function, in the role of women, and bear many similarities in structure. The differences that are found are felt to be primarily due to differences in socio-economic organization of the two communities. Historical factors are taken into consideration and the possibility that they provided stimuli for the similarities in the development of the market is explored.

PINSON CAVE: A RECAPITULATION

Carey B. Oakley, Jr.
Department of Anthropology
University of Alabama, University

During October, 1969, the Department of Anthropology, University of Alabama at Tuscaloosa, was notified by the Jefferson County Sheriff's Department that a quantity of osteological material had been discovered in a small cave several miles north of Birmingham. The Sheriff's Department, realizing that at least some of the skeletal material was human,

felt that it might represent the remains of an unsolved criminal case, or if not, at least be of archaeological significance. At this point, the author was requested to assist in determining the nature and circumstances of this find.

A program of intensive archaeological research from October, 1969, to August, 1970, revealed three distinct areas of aboriginal skeletal deposits within the confines of Pinson Cave.

Excavation of the rear slope exposed deposits of human bone associated with aboriginal artifacts. Also in this deposit was a considerable amount of recent animal bone and garbage. Most of these recent accumulations could be stratigraphically separated from the older human deposit. A vertical shaft, leading to the surface, was determined to be the source of the human material. This assumption was based on the fact that all of the human remains were found either directly beneath or down slope from this shaft. Multiple hypothesis suggests that most of the depositions on the rear slope were in the form of cadavers. Only one occurrence of a cremation bundle was noted.

The shelf, located in the roof of the southeast passage, presented another interesting problem. Remains of at least five individuals were found on this shelf. Due to the smallness of the shelf opening, and the fewer small bones present, it was concluded that only skeletal remains were placed on this shelf.

The entrance slope was the third area of archaeological interest. It was apparent that the northwest section of this slope was used less extensively for mortuary purposes than the rear slope.

Characteristic cultural material found in all three areas confirm the same relative age for all. Furthermore, the exclusive occurrence of distinctive Hamilton Projectile points confirm the single component nature of 1Je20.

Analysis of the skeletal material from Pinson Cave suggests that a minimum of 90 to 100 individuals may have been deposited within the cave. This estimate is based on 44 occurrences of the left talus bone in the excavated area and a projected estimate of 50 or more in the unexcavated portion of the cave. Other observations show that both male and female of all age groups were deposited. Skeletal makeup indicates that these people were slight in stature and possessed refined skeletal musculature. Numerous instances of pathological problems, both cultural and natural, were observed.

The chronological placement of the Pinson Cave Component in the Late Woodland cultural period is based on the diagnostic Hamilton projectile point. In addition, marine shell ornaments, deer cannon bone pins, sandstone saws, and sherd abraders indicate a strong relationship with the Late Woodland Hamilton Focus. Physical similarities between Pinson Cave and Hamilton people can be seen in the rather short gracile stature, dental pathological problems, low infant mortality rate, and the high instance of Hamilton projectile points embedded in skeletons.

Connections with several foci in Alabama are less apparent. The Copena Focus of northern Alabama exhibits similarities in the use of caves for mortuary purposes and the utilization of marine shell. However, the Copena Focus probably occurred earlier than the Pinson Component and the two may be related only indirectly.

Other relationships are indicated by the presence of two sand tempered red filmed sherds from Pinson Cave. A ceramic type resembling these sherds was designated as Laws Red Filmed on the basis of nine sherds from

Abstracts

the Guntersville Basin in northern Alabama. However, a comparison of the Laws Red Filmed type with Montgomery Red Filmed suggests duplication. The Montgomery Red Filmed is associated with the Hope Hull Focus concentrated around Montgomery, Alabama. This focus is estimated to be about the same chronological duration as the Hamilton Focus. A trade network is postulated, but not proven, on the similarity of certain cultural traits shared by the Hamilton Focus, the Pinson Cave Component, and the Hope Hull Focus. These trade items consist of marine shell and Montgomery Red Filmed vessels from the South and possibly high quality flint and other minerals from the North.

In summary, the following conclusions can be drawn: (1) This site was utilized as an ossuary, (2) This cultural phenomenon is attributed to a single distinctive culture tentatively termed the Pinson Cave Component, and (3) Diagnostic cultural traits from 1Je20 indicate that the Pinson Cave Component is a southern geographical variant of the Late Woodland Hamilton Focus of eastern Tennessee.

MAICOPA: A VILLAGE TO BE STUDIED, DISTRICT OF YECORA, SONORA, MEXICO

Margaret Z. Searcy
University of Alabama, University

The Maicobans of Baja Piman stock are a little known group of Indians which is fast nearing extinction. They are located in a remote valley (108°55'W, 20°23'N) in the Sierra Madre Occidental, Sonora, Mexico and have been isolated because of physical and economic barriers.

In 1968 and 1969 political unrest was felt throughout Mexico, and Maicoba was singled out as a trouble center; five "communist students" were shot. Government officials decided for reason of civil defense that roads must be built in the area. The construction project and the cooperation of the Federal Health Department and the Mexican Army enabled the author to make a brief report about some of the economic, social, and religious customs of these yet unstudied people.

ADAPTATIONS OF SALT-WATER FISHING TECHNIQUES TO THE LOCAL ENVIRONMENTS IN TWO GROUPS OF EASTERN AUSTRALIA

Elisabeth Shepard Sheldon
University of Alabama, University

The purpose of this study is to compare salt-water fishing methods of Australian Aborigines in the state of Victoria and in the Torres Straits islands, and to attempt to relate those methods to differences in the two environments.

The sandy coast of Victoria is characterized by shallow lagoons capped by dunes, and bordered on the seaward side by long sandy beaches; its climate has been described as temperate. The eastern Murray Islands of volcanic origin and the high rocky islands to the west in the Torres Straits region are surrounded by fringing reefs with shallow lagoons; the climate at this latitude is classified as rainy tropical.

Despite these differences in coastal morphology and climate, a

number of the same species of fish and shell-fish are exploited in both areas, due to their wide ecologic range.

Use of the more complex fishing techniques in the Torres Straits islands appears to be a direct result of trade with the peoples of New Guinea. With these exceptions, methods in common use reflect the underlying similarities in the fishing waters, i.e., shallow lagoons with tidal fluctuations.

Thus, water depths rather than coastal morphology or exploited species appear to be a major factor in determining which kinds of fishing methods will be most successful.

PLANT USES IN MEXICO AND PERU IN PRE-COLUMBIAN TIMES

C. Earle Smith, Jr.

Departments of Anthropology and Biology
University of Alabama, University

Although plant remains of later periods have long been known from Peru, pre-ceramic age plant remains are just now being investigated. For the first time, it is possible to compare plant uses for similar periods and stages of development in the two areas.

The Mexican area is well represented by plant remains from the caves in Tamaulipas, Tehuacan, and Oaxaca. The earliest material indicates major subsistence from gathering of plant resources supplemented by hunting. This gradually was supplanted by cultivated crop plants which furnished edible seeds and fruits primarily.

The first large collection of pre-ceramic plant remains from Peru shows very much the same basic pattern. The gradual replacement of wild plant resources by cultivated takes place. In this area, though, much greater emphasis on subsistence from underground portions of plants is apparent. Even the uppermost level, in which corn is replacing many other food plants in bulk, the root vegetables maintain their place.

EXCAVATIONS UNDER ST. PETER'S BASILICA -- IN QUEST FOR PETER

Dixon Sutherland
Samford University
Birmingham, Alabama

The question of Peter's activity in Rome is surely an anthropological one, for it concerns the faith of more than 550 million Catholics.

This paper examines the literary evidence indicating Peter's arrival into Rome, the support concerning his traditional martyrdom there, and the actual archaeological evidence as to his burial in Rome. Evidence found in the New Testament (I Peter 5:13) as well as 1st Century A.D. epistles from Ignatius, bishop of Antioch, and I Clement of Rome indicates that in all probability Peter did reach Rome. Again, it is Ignatius and I Clement, as well as Gaius, Roman presbyter, which provides the clues for establishing the validity of Peter's martyrdom at Rome. It is accepted that Peter did suffer martyrdom at Rome somewhere around the end of the Neronian persecution.

Abstracts

The archaeological evidence reveals the topography of Vatican Hill at the time of Gaius (A.D. 200), and the discovery of his "Trophy" under the Confession indicates that the tradition of Peter's burial at Vatican did exist at that time. There is no conclusive evidence, however, as to his burial at Vatican Hill, for excavations reveal only remains which cannot be identified. The only conclusion obtainable is that Peter did reach Rome, was martyred there, and was later believed to be buried there.

ADDENDUM TO BIOLOGICAL SCIENCES

TELEMETERED THERMAL RESPONSES OF THE VIRGINIA OPOSSUM (*DIDELPHIS MARSUPIALIS*)

Gary Dills
Department of Biology
University of Alabama, University

The telemetered deep-core temperature of a male opossum changed 6.6°C when exposed to increasing air temperature and 3.5°C when exposed to ambient temperature. The diel temperature fluctuation of the animal showed highest temperatures during the night hours with an overall diel temperature change of 3.7°C . The principle of monitoring deep-core temperature by telemetry in small mammals was evaluated.

Journal of the Alabama Academy of Science

MINUTES ANNUAL BUSINESS MEETING, ALABAMA ACADEMY OF SCIENCE UNIVERSITY OF ALABAMA, UNIVERSITY April 3, 1971

The annual business meeting was called to order in Morgan Auditorium by President Furman at 11:50 A.M. President Furman moved that the minutes of the April 11, 1970 meeting be approved. The motion was seconded by Dr. Skorski and passed.

REPORT OF THE PRESIDENT, by Father Furman: "Preparations for the annual meeting at the University of Alabama were completed."

REPORT OF THE SECRETARY, by Tom Denton: "The secretary reports a total membership for April 1, 1971 of 1,104 members. The total membership for November, 1970 was 1,016. This was a net gain of 88 members. Registration for the 1971 meeting reached 172."

REPORT OF THE TREASURER, by W. F. Arendale:

RECEIPTS	ACTUAL	ESTIMATED
Membership Dues	\$4,000.00	\$4,000.00
NSF-Grants-Indirect Costs		85.00
Annual Meetings	957.25	1,000.00
Research Grants	400.00	200.00
Miscellaneous (Industry contributions to AJAS)		
	<u>2,275.00</u>	<u>2,500.00</u>
	\$7,632.25	\$7,785.00
EXPENDITURES	ACTUAL	BUDGET
Publication of Journal		\$2,650.00
Postage		
Honararia for Editor		400.00
Assistance to AJAS		
Support		250.00
Industry Contributions	2,300.00	2,500.00
Student Awards	130.00	120.00
Research Grants	400.00	400.00
Annual Meetings		
Meals Cost, Host Institution		-0-
Expenses Net		600.00
Programs	354.86	200.00
Academy of Science Award	100.00	150.00
Speakers, Officers, Expenses, etc.		200.00
Academy of Science Assessments	18.70	20.00
Operating Expenses		
Office of the President		125.00
Office of the Secretary	370.99	500.00
Office of the Treasurer	193.43	200.00
Office of the Editor-Newsletter		50.00
Office of Coordinator Science Fairs	50.00	150.00
Office of the Counselor AJAS		-0-
Public Relations Committee		100.00
Supplies		150.00

Minutes

	ACTUAL	BUDGET
Newsletter	56.29	100.00
Chairman, Membership Committee		150.00
Vice-Presidents (11 x \$20)	97.13	220.00
	<u>\$4,071.40</u>	<u>\$9,235.00</u>

Balance in Checking Account 12-31-69	\$2,108.94
Total Receipts	7,632.25
Total Expenditures	<u>-4,071.40</u>
Balance in Checking Account 12-31-70	<u>\$5,669.79</u>

First National Bank, Huntsville, Alabama, Savings Certificate		
Issued 7-22-69	Value 12-31-69	\$7,088.05
	Value 12-31-70	\$7,451.46

"It was announced that the place of meeting for 1972 will be at Jacksonville State University, April 13, 14, and 15."

REPORT OF THE RESOLUTIONS COMMITTEE, by John Locker, Chairman:

"Your Resolutions Committee submits the following resolution:

WHEREAS our fossil fuels, coal, oil, and natural gas, and other natural resources are in limited supply and

WHEREAS the quantity of usable water on earth is finite and is constantly decreasing due to the irresponsible actions of man and

WHEREAS the very air we breathe in many of our cities and industrial centers is contaminated to the degree of endangering human health

BE IT RESOLVED that the Alabama Academy of Science supports efforts to promote an awareness of the environmental problems of the state, to encourage corrective and preventive legislation, and to utilize all reasonable avenues to preserve a high quality environment for the citizens of the state and for all mankind.

BE IT FURTHER RESOLVED that the Academy send copies of this resolution to members of the legislative and governing branch of the State of Alabama."

"Your Resolutions Committee submits the following resolution:

WHEREAS the Alabama Academy of Science is successfully engaged in the Forty-Eighth Annual Meeting on the campus of the University of Alabama, therefore, be it resolved:

a) That the Academy express appreciation to the officials of the University of Alabama and to its President, Dr. F. David Mathews for their hospitality;

b) That special appreciation be expressed to Mr. C. E. Adams, Coordinator of Conference Activities; Dr. H. D. Hays, General Chairman; Dr. J. F. Vallery, Chairman of the Local Arrangements Committee for

Journal of the Alabama Academy of Science

Senior Academy; Dr. R. H. Gardner, Chairman of the Local Arrangements Committee for Junior Academy; and their co-workers whose untiring efforts contributed in no small way to the success of the meeting;

c) That the Academy express its appreciation to the Sargent-Welch Company for its hospitality in underwriting a substantial portion of the cost of the annual banquet."

Dr. Joe Thomas, sponsor of the AJAS, expressed his appreciation to the University of Alabama for its hospitality during the 1971 meeting.

REPORT OF THE NOMINATING COMMITTEE, by Wilbur DeVall: "This year's Nominating Committee consisted of Jim Sulzby, Howard Carr and Wilbur DeVall, Chairman.

The committee submits herewith its nominations for elective offices.

President-elect (term 1971-'72)

Joseph Thomas

Secretary (term 1971-'74)

Tom Denton

Counselor AAAS (term 1971-'74)

Roman Skorski

Counselor AJAS (term 1971-'74)

James D. Welker

Coordinator of Science Fairs (term 1971-'74)

George Twellmeyer

Journal Editor (to complete unexpired term of Askew 1971-'72)

Elroy Curl

Board of Trustees (terms 1971-'74)

James Sulzby
Harry Philpott
J. F. Fagan
Howard Milling

SECTION OFFICERS

1. Biological Sciences

Vice-President: H. R. Cunningham, Auburn University

Minutes

Vice-Chairman: J. S. Brown, Florence State University

2. Chemistry

Vice-President: Carlton Whitt, Monsanto Chemical Company

Vice-Chairman: Virgil M. Benson, Jacksonville State University

3. Geology

Vice-President: Michael W. Szabo, University of Alabama

Vice-Chairman: Denny N. Bearce, Birmingham-Southern College

4. Forestry, Geography, and Conservation

Vice-President: Merle Sherman, Florence State University

Vice-Chairman: John Bourne, Florence State University

5. Physics and Mathematics

Vice-President: Bernis Hannah, Samford University

Vice-Chairman: J. Raymond Cooper, Auburn University

6. Industry and Economics

Vice-President: Barry Mason, University of Alabama

Vice-Chairman: Charles Leoins, University of Alabama

7. Science Education

Vice-President: Mary Carlson

Vice-Chairman: Ernest Riggsby

8. Social Sciences

Vice-President: Frances Roberts, University of Alabama, Huntsville

Vice-Chairman: Wesley P. Newton, Auburn University

9. Medical Sciences

Vice-President: Charles P. Dagg, University of Alabama, Birmingham

Vice-Chairman: Fred Gilbert, Baptist Medical Center, Birmingham

Journal of the Alabama Academy of Science

10. Engineering

Vice-President: D. C. Raney, University of Alabama

Vice-Chairman: John E. Cochran, Jr., Auburn University

11. Anthropology

Vice-President: Karen Joines, Samford University

Vice-Chairman: C. Earle Smith, Jr., University of Alabama

The report by Dr. DeVall came in the form of a motion, was seconded by Roman Skorski, and passed unanimously.

REPORT OF THE AUDITING COMMITTEE, given by Dr. Foster for Dr. Shatas "Auditing of the financial records of the Alabama Academy of Science has been performed by the Auditing Committee on March 29, 1971. No discrepancies were noted and the records were found to be in excellent order. The auditing committee would like to express thanks to Mrs. W. F. Arendale for the excellent bookkeeping. Balances of \$10,672.16 as of 16 March, 1971 in the checking account and of \$7,545.19 as of 22 January, 1971 in the savings account were noted.

In addition, the auditing committee would like to recommend that the date of annual audits be changed to coincide with the Academy's Fiscal Year termination (31 December). An additional audit at the time of Annual Meetings then would be necessary if the Treasury books are transferred to another individual."

At this time certain awards and recognitions were made. Mrs. *Elsie Spencer* was presented as the *Outstanding Teacher of the Year* by Dr. John Holland. The Science Fair Winners were then presented by Rev. Twellmeyer. They are as follows:

CENTRAL REGION:	Robert H. Shine, Jr., Mountain Brook High School
	Ricky Kettinger, W. A. Berry High School
MOBILE REGION:	Karen Howard, T. R. Miller High School
	Greg Cooper, T. R. Miller High School
NORTHERN REGION:	Michael W. Brown, Grissom High School
	Martha Jane Wood, Austin High School

Minutes

NORTHWESTERN REGION: Donna Johnson, Colbert Heights High School
Mike Moore, Haleyville High School

NORTHEASTERN REGION: Charles Kenny Brothers, Etawah High School
David A. Rothenanger, Childersburg High School

WESTERN REGION: Alan Baumeister, Tuscaloosa High School
Owen Stallworth, Tuscaloosa High School

SOUTHERN REGION: Lamar Rhodes, Opp High School
Tey Johnson, Opp High School

"These Finalists have won the honor to represent their regions at the International Science and Engineering Fair to be held in Kansas City, Missouri, May 10-15, 1971."

George O. Twellmeyer, State Coordinator

Dr. Bob Taylor presented the winners of Student Research Awards. They were awarded cash awards and certificates.

STUDENT RESEARCH AWARDS

I. Biological Sciences

First Place: Charles J. Hannan, Jr., Department of Microbiology,
University of Alabama
"Reduction of Krebs' Cycle Enzyme Activity in
Mouse Liver after Treatment with Rubratoxin B"

II. Physical Sciences

First Place: J. E. Johnson, School of Engineering, Auburn
University
"Wind Tunnel Studies of Aerodynamic Interaction
Between C. O. E. Trucks and Cars"

III. Social Sciences

First Place: James R. Stovall, Florence State University
"Critical Population Densities with Respect to
Africa South of the Sahara"

Second Place: Michael E. Hardin, Florence State University
"An Analysis of the Evolution of the Urban Character of Decatur, Alabama"

Journal of the Alabama Academy of Science

Dr. Feazel then presented the winners for the Gorgas Foundation. Winners are:

First Award (4-year cash award totalling \$1800): Texel Dewine Johnson, Perry Store Road, Opp, Alabama. His high school advisor is Miss Brenda Hackler of Opp High School.

Second Award (4-year cash award totalling \$1350): Robert Lee Taylor 1328 - 29th Street, North, Birmingham. His high school advisor is Mrs. Carlotta D. Harris of Parker High School.

Third Award (4-year cash award totalling \$900): Mary Jane Evans, 1412 6th Avenue, S. W., Decatur, Alabama. Her high school advisor is Mr. Dean McMinn from Austin High School.

Fourth Award (4-year cash award totalling \$750): Mark Pressley Jones, 106 Moore Avenue, Opp, Alabama. His high school advisor is Miss Brenda Hackler of Opp High School.

First Alternate: Stephen Reid Bostic, 117 Lynbrook Drive, Brewton, Alabama. His high school advisor is Mrs. Lida McDowell of T. R. Miller High School.

Second Alternate: Alice Jean Bramlett, Route 1, Box 245, Hartselle, Alabama. Her high school advisor is Mr. John H. Teague of Falkville High School.

Third Alternate: Tilman Werner Stuhlinger, 3106 Rowe Drive, Huntsville, Alabama. His high school advisor is Miss Rebecca T. Garland of Lee High School.

Fourth Alternate: Richard Morris Gilley, 506 Everett Drive, S. W., Decatur, Alabama. His high school advisor is Mr. Dean McMinn of Austin High School.

Fifth Alternate: Marie Ann Fay, 113 Virginia Drive, Brewton, Alabama. Her high school advisor is Mrs. Lida McDowell of T. R. Miller High School.

Sixth Alternate: Jimmie Ray Dockery, 122 Short 25th Avenue, E. Tuscaloosa, Alabama. His high school advisor is Miss Ella H. Price.

In addition to the cash awards, all ten finalists will be offered four years tuition free scholarships from at least three Alabama Universities. The finalists are selected on the basis of their high school records and their entries in the nationwide Westinghouse Science Talent Search.

The Gorgas Foundation is named for General William Crawford Gorgas, the Alabama physician who conquered yellow fever in the Panama Canal zone while serving as Surgeon General of the U. S. Army. The purposes of the Foundation are to promote interest in science and to aid in the education of promising students.

Minutes

Members of the Gorgas Scholarship Foundation Committee are Dr. Emmett B. Carmichael, University of Alabama in Birmingham; Dr. Charles E. Feazel, Southern Research Institute; Dr. William A. Short, Athens University; and Dr. Travis H. Hughes, University of Alabama."

The meeting was then turned over to the new President, Mr. G. O. Spencer. After requesting that everyone help the new President make the next year a good one for the Academy, the meeting was adjourned.



026.0A

THE JOURNAL

OF THE

ALABAMA ACADEMY
OF SCIENCE

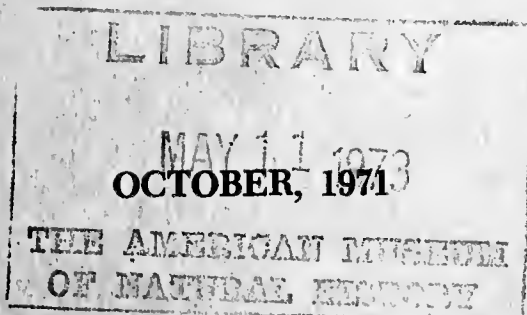
AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830

VOLUME 42

MAY 11 1973
OCTOBER, 1971

NUMBER 4



THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

VOLUME 42

OCTOBER, 1971

NUMBER 4

EDITOR

Elroy A. Curl
Auburn University

ARCHIVIST

Clyde H. Cantrell
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman
Auburn University

Elroy Curl
Auburn University

Ann Everett
Crossville High School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ARTICLES

Governors, Politicians, and the Sources of Instability in the Colonies: New Jersey as a Test Case John R. McCreary	215
Value Issues in Sociology and Science Generally Chester W. Hartwig	228
Maicoba: A Village to Be Studied—District of Yecora, Senora, Mexico Margaret Z. Searcy	237
<i>Ergasilus wareaglei</i> sp. n. (Copepoda: Cyclopoida) from North American Catostomid Fishes Sterling K. Johnson	243
Are Lunar Rocks Igneous in the Same Sense as Earth Rocks? Reynold Q. Shotts	248
A Vacuum X-Ray Reflectometer John M. Reynolds	253
Reflection Efficiency of Various Materials in the X-Ray Regions of 0.8 to 2.5 nm and 4.4 to 8.0 nm Stanley A. Fields	264
INDEX	282

Governors, Politicians, and Sources of Instability

GOVERNORS, POLITICIANS, AND THE SOURCES OF INSTABILITY IN THE COLONIES: NEW JERSEY AS A TEST CASE

John R. McCreary
Department of History
Columbus College, Columbus, Georgia

American colonial history has undergone a variety of interpretations. But for the most part, until comparatively recent times, historians concentrated on one theme--the ongoing struggle between the governors and the elected lower houses of assembly. Indeed, Charles M. Andrews, dean of American colonial historians, whose monumental work¹ contributed so greatly toward popularizing the so-called "imperial school" of American colonial historiography, wrote in 1943 that "the most conspicuous feature of the political and institutional aspects of development in the eighteenth century...was the rise of the colonial assembly with its growth to self-conscious activity and *de facto* independence of royal control."²

This thesis, while accepted in its day, and currently in the process of being revitalized by several colonial specialists,³ contributed little toward a more realistic appraisal of eighteenth century politics than that of the so-called patriot school of the nineteenth century. The "imperial" approach laid emphasis on the whole rather than the component parts of colonial America, and mistakenly distorted reality in search of a workable generalization. It ignored social, economic and political phenomena, which were the materials of which the American political framework was cast, as competing interests and factions were lost to the overriding concern for developing an all-encompassing interpretation for colonial history.

Early in the twentieth century, a small number of historians began the search for more satisfactory answers in attempting to explain the course of American colonial history. Although many of their efforts were marked by crude analysis involving class conflict and social discord, they did focus on the colonies' internal political divisions, caused by the

¹Charles M. Andrews, *The Colonial Period of American History* (4 vols., New Haven, 1934-38). Beginning his writing in 1899, Andrews completed this, his *magnum opus*, in his retirement.

²Taken from Andrews, *The Colonial Background of the American Revolution: Four Essays in American Colonial History* (New Haven, 1924), 30, and "On the Writing of Colonial History," *The William and Mary Quarterly*, third ser., I (Jan., 1944), 39. (Hereafter referred to as *W&MQ*).

³Under the general rubric of Neo-Imperialists I would include studies by Lawrence H. Gipson, *The British Empire Before the American Revolution* (14 vols., to date, Caldwell, Idaho and New York, 1936-); and Jack P. Greene, *The Quest for Power: The Lower Houses of Assembly in the Southern Royal Colonies, 1689-1776* (Chapel Hill, 1963).

clash of class and economic interests.⁴ Their writings prompted Professor Andrews, in the twilight of his career, to admit that an understanding of colonial politics was impossible without an "understanding of the social and propertied interests involved, class distinctions and personal rivalries, the motives of majorities, and the ambitions of political leaders."⁵

With this admonition in mind, historians since World War II have made some detailed explorations into the world of colonial politics and government.⁶ Their efforts have elucidated, for some of the colonies, the domestic entanglements, rivalries and grievances which divided men and determined the course of colonial politics in the eighteenth century. They demonstrate the danger of generalization about the North American colonies as a monolithic entity, for local and state studies focus, of necessity, on the substantive rather than the ephemeral; on the concrete as opposed to the hypothetical; on action instead of ideology.

Two factors remain yet to be considered. The first was outlined in a perceptive and ground-breaking essay over a decade ago by Bernard Bailyn.⁷ He found that a permanent conflict existed within the uppermost

⁴The prototype of these works was that of Carl Lotus Becker, *The History of Political Parties in the Province of New York, 1760-1776* (Madison, Wisc., 1909).

⁵Andrews, "On the Writing of Colonial History," 40.

⁶Some of the most notable of these include: Oscar Zeichner, *Connecticut's Years of Controversy, 1750-1775* (Chapel Hill, 1949); William W. Abbott, *The Royal Governors of Georgia, 1754-1775* (Chapel Hill, 1959); Kenneth Coleman, *The American Revolution in Georgia, 1763-1789* (Athens, 1958); M. Eugene Sirmans, *Colonial South Carolina, A Political History 1663-1763* (Chapel Hill, 1966); Jerome R. Reich, *Leisler's Rebellion: A Study of Democracy in New York, 1667-1720* (Chicago, 1953); and the more thorough and perceptive Lawrence Leder, *Robert Livingston and the Politics of Colonial New York* (Chapel Hill, 1961); William Hanna, *Ben Franklin and Pennsylvania Politics* (Philadelphia, 1964); Aubrey C. Land, *The Dulanys of Maryland* (Baltimore, 1956); and John A. Schutz, *William Shirley: King's Governor of Massachusetts* (Chapel Hill, 1961). Some other notable works which deal with the machinations of colonial politics, but which have never been published include: Beverly McAnear, "Politics in Provincial New York, 1689-1761" (Unpublished Ph.D. dissertation, Stanford University, 1935); Leslie J. Thomas, "Partisan Politics in Massachusetts during Governor Bernard's Administration, 1760-1770," (Unpublished Ph.D. dissertation, University of Wisconsin, 1960); Jere R. Daniell, "New Hampshire Politics and the American Revolution, 1741-1790" (Unpublished Ph.D. dissertation, Harvard University, 1964); and Larry R. Gerlach, "Revolution or Independence? New Jersey, 1760-1776" (Unpublished Ph.D. dissertation, Rutgers University, 1968).

⁷Bernard Bailyn, "Political and Social Structure in Colonial Virginia," in James M. Smith, ed., *Seventeenth Century America* (Chapel Hill, 1959), 90-115.

Governors, Politicians, and Sources of Instability

level of American society because of a division of political authority. In the traditional, deferential society the social and economic elite exercised political authority, while providing a coterie of local leadership. While this elite felt itself bound to lead and govern, it was at the same time engrossed in the competition for place in a fluid New World environment which allowed men to gain wealth and status but limited the number of desirable positions. This approach, if pursued, can lead to an elucidation of a major source of political instability in colonial America.

One further dimension must be assessed. Political factions operated within a colony and exploited the division of authority between local and imperial power. Most recently a few studies have sought to examine the impact of factional politics on the local scene and to elucidate the imperial connection.⁸ They have demonstrated the inadequacy of writing American colonial history as merely a struggle within the local arena and ignoring the external authority. Most politicians realized that ultimate power lay outside the province; indeed, outside North America itself. Such an awareness necessitates the analysis of English politics, and perhaps more importantly, the political connections of provincials in the administrative boards and offices which dealt with colonial affairs. For it was here, at the Plantation Office, and particularly among its under-secretaries, secretaries, and commissioners that recommendations, if not actual decisions, were made. And it must be recognized that these men possessed their own family and factional ties, as well as their particular economic interests. It is in these two factors--the inherent mobility and flux in colonial society itself, and the fact that the governor's powers were less real than apparent--that the fundamental sources of colonial political instability can be found.

Between the Restoration of Stuart rule in 1660 and the abortive uprising of the Pretender James in Scotland in 1715, the party labels of Whig and Tory legitimately delineated political groups in England.⁹ Tainted with the stigma of Jacobitism, the Tories after 1720 ceased to be an effective force in English politics, but their demise did not bring an end to political strife in England. Rather, the conduct of politics became less attuned to national issues, and came to consist of contests among certain political *illuminati*, the great political families, and various factional interests, under the amorphous label of Whig. As Sir Lewis Namier put it, "In 1706 it was faithful service to your country," while

⁸The prototype of this sort of study is Schutz, *William Shirley*. See also Stanley N. Katz, *Newcastle's New York, Anglo-American Politics, 1732-1753* (Cambridge, 1968).

⁹See: Ian F. Burton, P.W.J. Riley, and E. Rowlands, *Political Parties in the Reigns of William III and Anne, The Evidence of Division Lists, Bulletin of the Institute of Historical Research*, no. 7 (November, 1968). A thorough analysis of division lists shows the existence of political splits along these "party" lines.

by 1760 "service to one's friends,"¹⁰ had come to predominate in English, as in colonial politics. The holding of office had become a passion, with its own *raison d'être*, and a politician's power was gauged by the amount of patronage at his disposal.

Such a political system, constructed on patronage and on individual and family alliances aimed at gaining and holding political power, with the sometimes subtle, sometimes rapid alterations of factions, affected the conduct of colonial affairs. Major responsibility for colonial administration fell to the Board of Trade, a body created in 1696. The Board played an important role, and quite naturally positions on such boards were political plums, as were appointments to offices in the colonies. The royal governor was ordinarily appointed because of his connections with a prevailing faction, and a change in the English ministry might well bring disaster for his administration.

Thus the governor was placed in a uniquely difficult situation, forced to maintain a constant surveillance of political developments within his colony, and concurrently to keep abreast of the English political scene, for provincials also forged transatlantic political and family alliances. The dissident colonist, resentful of his treatment by a governor, had at his disposal two courses of action. He could launch an attack within the colony, normally conducted within the assembly and the press, and he could carry his fight to England, in the hope of utilizing superior political interest there to obtain the governor's compliance or removal. All of these factors contributed mightily to the inherent instability of colonial politics.

It has been said of New York's politics in the colonial period that "There were no political parties; there were rather two centers of influence, and the only division that was permanent was that between the men who at any time were attached to the governor's interest and the men who made use of the assembly to thwart that interest."¹¹ This may also be said of the political structure in New Jersey in the eighteenth century. In attempting to weld the colony into a working unit, the royal governors were harrassed by competing land speculators, by religious conflicts among Quakers, New England Puritans, Scottish Calvinists, and the influential Anglicans. They were additionally beset by the piques of irritated, ambitious, but unsuccessful Jersey politicians, whose inability to influence the executive and win admission to the provincial Council, or

¹⁰Sir Lewis B. Namier, *England in the Age of the American Revolution* (London, 1930), 18, 230-31. See also, *The Structure of Politics at the Accession of George III* (2d ed., London, 1957); and with John Brooke, *The History of Parliament: The House of Commons, 1754-1790* (London, 1964), particularly vol. I. For a detailed analysis of factions at the accession of Anne, see Robert Walcott, *English Politics in the Early Eighteenth Century* (Cambridge, 1965).

¹¹Becker, *The History of Political Parties in New York*, 7-8.

gubernatorial support for their cause, drove them into opposition.¹²

The legislative assembly ordinarily became the vehicle for that opposition, and yet in the case of New Jersey there is no evidence that there was an irreconcilable struggle between the executive and legislative institutions. Much of the success or failure of colonial politics depended on the sagacity of the governor. Able men enjoyed successful, if hazardous tenures in office (barring English political complications) while the less able found the tumult of unrestrained factional politics more than they could abide. For men, rather than institutions, are the moving forces of history. Where disputes arose between governor and "assembly," it is not sufficient merely to contend that the prerogative was being challenged by a monolithic body. Such disputes are traceable to conflicts of personalities and interests rather than to inherent and irreconcilable antagonisms between governing institutions.

The political structure of New Jersey was in a constant state of flux, as the social and economic mobility which marked the colonial period in British North America constantly elevated new men to compete for the relatively limited number of positions available in local government. Those who found favor with the governor exerted themselves to secure adequate recompense for him and the civil list, and to secure military and defense appropriations by which the executive could justify his administration to imperial authorities. Opponents, anxious for the offices held by governors' favorites, lost no opportunity to discredit an executive.

By 1700 the proprietary period of New Jersey's history was drawing to a violent close. The proprietors divided into two groups, and the proprietary conflict ranged along lines of religious and landed divisions. By 1701 the progression of events in East and West Jersey forced proprietors of both persuasions to seek royal intervention, and in 1702 they requested, and received, the assumption of the two Jerseys into a royal colony. East and West Jersey were united, and the royal colony of New Jersey, with its own legislative assembly, was ordered to share a governor with New York.¹³ This situation would ensue until 1738, when a separate post was created to pacify a leading Jersey politician.

¹²For a comprehensive discussion of sectional, religious and related divisions in New Jersey, and the causes of those divisions, see: John E. Pomfret, *The Province of West Jersey, 1609-1702* (Princeton, 1956); and his companion work, *The Province of East New Jersey, 1609-1702* (Princeton, 1962). A third work, *The New Jersey Proprietors and Their Lands, 1664-1776* (Princeton, 1964), is more general, and based in large part on the two earlier monographs. Also quite informative is Frederick R. Black, "The Lords Proprietors of West Jersey: The West Jersey Society, 1692-1702" (Unpublished Ph.D. dissertation, Rutgers University, 1964).

¹³John Hamilton to New Jersey Board of Proprietors, 1 June 1700, New Jersey MSS., I, no. 5, New Jersey Historical Society, Newark; Minutes of Governor and Council, 20 December 1700, East Jersey Council Journal, New Jersey Historical Society, Newark; Report on the state of the American Plantations, by Stamford, Blathwayt, Lexington, Pollexfen, Meadows, Hill

The dominant figure in New Jersey's politics during the first forty years of the eighteenth century was Lewis Morris, a large landowner in both New York and New Jersey, and a major figure among the resident "Scotch" proprietors of East Jersey. There is considerable evidence that Morris was in line to assume the governorship of the new royal colony in 1702, until his appointment was blocked by two prominent English politicians--the Earl of Clarendon and Lord Rochester. Morris was bypassed in favor of Edward Hyde, Lord Cornbury, who had recently been appointed governor of New York.¹⁴ There is little doubt that politics entered into the decision, for Cornbury was Clarendon's son, and a cousin of Queen Anne, and Rochester, his uncle, was head of the Tory party. At any rate, his appointment created in Morris an enemy who would relentlessly oppose Lord Cornbury during seven frustrating years as governor of the Jerseys.

Edward Hyde, Lord Cornbury, served New York and New Jersey as governor between 1702 and 1709. During those years he was beset by conflicts growing out of proprietary squabbles in the Jerseys. The resident "Scotch" proprietors, under Morris, Thomas Gordon, and George Willocks, were in control in East Jersey, although they were opposed by an English-based East Jersey Board of Proprietors, headed by William Dockwra and Peter Sonmans. Dockwra and Sonmans operated in concert with a powerful proprietary faction in West Jersey, under the control on the Anglican faction of Colonel Daniel Coxe, Jr. and Jeremiah Basse. This forced the rival West Jersey Society, along with the West Jersey Quakers, to seek assistance from the Morris-led "Scotch" proprietors.¹⁵ This proprietary alliance was the key to New Jersey's politics during the ensuing twenty years.

Both of these rival coalitions sought the new governor's favor, with the "Scotch" faction of East Jersey actually offering him £200 in gifts in exchange for his assistance.¹⁶ The Coxe group, however, proved successful,

and Prior, Public Record Office, London, Colonial Office Papers, 324/7/pp. 447-48. (Hereafter referred to as P.R.O., C.O.); Memorial of the Proprietors of East and West Jersey to the Board of Trade, 12 August 1701, W.A. Whitehead, W. Nelson, F.W. Ricord, eds., *New Jersey Archives*, first series, 30 volumes (Newark, 1880-1893), II, 404-408. (Hereafter cited as *NJA*).

¹⁴James Logan to William Penn, Philadelphia, January, 1702, The Logan Papers: James Logan Letterbooks, 4 vols., I, 55-73, Historical Society of Pennsylvania, Philadelphia. Logan was himself a West Jersey proprietor, Pennsylvanis's provincial secretary, and a long-time agent and confidant of the Penn family.

¹⁵James Logan to William Penn, n.d. [1703], The Logan Papers, James Logan Letterbooks, 4 vols., I, 55-73, Historical Society of Pennsylvania; Lewis Morris to the Earl of Sunderland, 9 February 1707/8, *NJA*, III, 274-75.

¹⁶James Logan to William Penn, 8 July 1703, Logan Letterbooks, 4 vols., I, 119; Lewis Morris to the Earl of Sunderland, 9 February 1707/8, *NJA*, III, 207-09, 262, 274-85.

Governors, Politicians, and Source of Instability

for it had the support of several influential men. Their cause was pled with the new governor by his father, the Earl of Clarendon, and by the influential admiralty judge for Pennsylvania and the Jerseys, Colonel Robert Quarry.¹⁷

Thus by 1703 New Jersey's factional alignments were firmly drawn. The object of these alignments, beyond the traditional Anglo-American desire of socially and economically prominent individuals to control desirable offices, was the control of the proprietary lands. Coxe and the West Jersey Society were rival claimants of thousands of acres in West Jersey, while Sonmans and Dockwra opposed Morris's attempts to control land titles and land policy in East Jersey. Cornbury's decision to support the pretensions of Coxe, Sonmans and Dockwra proved a serious blunder. For by misjudging the strength of his opposition and by failing, out of loyalty to his original supporters, to accommodate himself to the demands of the Morris-Quaker faction, Cornbury made himself the object of one of the most vitriolic attacks on record in an age when rhetorical overstatement was an acceptable *modus operandi* for politicians.

Factions were rather evenly divided in New Jersey, but the events of 1703 altered that situation. The deaths of two pro-Morris men on the provincial council, and their replacement with Coxe men gave the Governor's allies a majority on the provincial council in that year. But in the elections for the general legislative assembly, a combination of Quaker voting strength in West Jersey, combined with Morris's manipulation of elections in East Jersey, gave the Morris-Quaker faction a majority in the assembly.¹⁸ Cornbury was thus faced with a situation which militated against his best interests. He had been instructed to secure a militia act and an adequate support measure for the civil list and the governor's salary, yet the branch of government which had the power of the purse, the legislative assembly, was in the hands of a faction led by Lewis Morris.

¹⁷William Penn to James Logan, 31 October 1703, Logan Papers; Correspondence of James Logan, 2 vols., I, 37, Historical Society of Pennsylvania, Philadelphia; James Logan to Penn, 2 September 1703, Logan Letterbooks, 4 vols., I, 108-118. Logan reported that by September of 1703 Coxe had become "L[or]d C[ornbury]'s great friend." Governor Cornbury to the Board of Trade, 18 November 1706, W.N. Sainsbury, *et al.*, eds., *Calendar of State Papers, Colonial Series, America and West Indies* (38 vols., London, 1880-), 1706-08, p. 311-12. (Hereafter referred to as *CSPC,AWI*). Petition of West Jersey Proprietors to the Board of Trade, n.d., [1705]; Charles Dunster to an English proprietor, n.d. [1725], *NJA*, III, 117-18; V, 103; Enclosure in a letter from Clarendon to the Secretary of State, 1 September 1702, *NJA*, II, 501.

¹⁸Governor Cornbury to the Board of Trade, 9 September 1703; Lewis Morris to the Earl of Sunderland, Secretary of State, 9 February 1707/8; Address of Lieutenant Governor and Council to Lord Lovelace, April, 1709, *NJA*, III, 106; 274-85; 390-415; Journal of Governor and Council, 14 August 1703, I, 301. (Published as volumes XIII and XIV of the first series of New Jersey Colonial Documents, these two volumes will hereafter

Cornbury endured months of deliberation at two separate legislative sessions, without securing any of his instructions. Ultimately, realizing that no acceptable action would be taken by the group currently in control of the assembly, the governor dissolved the body and called new elections.¹⁹ Cornbury and his cohorts lost little time in applying a lesson learned from the Morris faction, and Cornbury placed the new elections under the supervision of Daniel Coxe, Jr. and Colonel Robert Quarry. Although they again proved unable to obtain a legitimate majority in the assembly elections, they did manage to exclude from the body three Quaker representatives on the grounds, (later disproved), that they lacked sufficient property to qualify them for the assembly. By these means, the Governor's faction obtained a majority.

They then proceeded to enact a severe militia act, to alter the voting franchise to include more "freeholders," to reapportion assembly seats in order to give Coxe an advantage against the Quakers in West Jersey, and finally, they passed a £2,000 support measure for the governor.²⁰ This action precipitated a total break between Morris and the Governor. Morris, who had served since royalization as the province's senior councillor, attempted to block the revenue act by arguing against it on the grounds that it was inadequate. This was the same Morris who only a year earlier had contended that a revenue measure half its size

be referred to as Journal of Governor and Council). Morris had managed to wangle the appointment of Thomas Gordon as Sheriff of Middlesex County, where all East Jersey elections were held at Perth Amboy. The Sheriff was in charge of the polls, and although the best accounts place the total vote for the "Scotch" candidates at forty-two, as opposed to between three and four hundred for the opposition, Gordon simply rejected most of the opposition votes, carrying the election for the Morris faction and giving it five critical assembly seats. In West Jersey the Quakers had argued that "unless they chose Quakers [to the assembly] that tythes, the militia, and great taxes would be established by the Assembly." Colonel Robert Quarry to the Board of Trade, 20 December 1703, P.R.O., C.O. 5/970/14.

¹⁹Governor Cornbury to the Board of Trade, 4 September 1704, *NJA*, III, 65-67; Robert Quarry to the Council of Trade and Plantations, 15 October 1704, P.R.O., C.O. 5/1263/6. In Cornbury's words, "The Reasons why I dissolved the first Assembly were evident to all Mankind; for it was plain that the House never intended to do anything for the support of the Queen's Government, nor for the good of the Country; and indeed better could not be expected from an Assembly so corruptly chosen as that was...."

²⁰Colonel Robert Quarry to the Board of Trade, 28 June 1707, P.R.O., C.O. 323/6/no. 61. [transcripts in the Historical Society of Pennsylvania]; Lewis Morris to the Earl of Sunderland, 9 February 1707/8; Memorial of the Proprietors of West Jersey to the Board of Trade, 17 April 1705; Affidavit of George Ingoldesby, 16 July 1706, *NJA*, III, 85-95; 150-54; 274-85; Deposition of a Mr. Hamilton, 19 May 1708, *CSPC,AWI*, 17-6-08; p. 732.

was "excessive." When the effort failed, Morris simply walked out of the provincial council, and was suspended by the governor.²¹

At this juncture, the struggle shifted to England for its resolution, as both factions sought to exploit their contacts within the ministry and the administrative boards in order to have their way. Coxe and Sonmans relied heavily on their London ally, William Dockwra, who was Secretary of the East Jersey Board of Proprietors, and whose contacts on the Board of Trade were excellent. Morris and his cohorts relied most heavily on the influence of the West Jersey Society, the leading proprietors of which were based in London. They also had sound influence with the Board of Trade. Sir Thomas Lane was a former Lord Mayor of London, while Paul Docminique, a staunch Whig, would later himself be named to the Board of Trade.

Meanwhile, Cornbury's English patrons were losing their influence, and this was critical to events in the Jerseys. His uncle, Lord Rochester, was head of the Tory Party, and it was he who had secured Cornbury's appointment in 1702. Rochester's Tories were losing ground to the Whigs,²² and this undermined the Governor's support with the Board of Trade. In the past William Blathwayt, a staunch Tory, had solidly backed Cornbury. As the course of English politics began to run against the Tories, however, Blathwayt lost influence,²³ and ultimately the majority of the Commissioners of Trade turned on the Governor, ordering him to reinstate the three Quakers who had been excluded from the last session of the assembly, and advising him "to leave the Determination about Elections of

²¹Governor Cornbury to the Board of Trade, 19 February 1704/5; Address of the Lieutenant Governor and Council to Lord Lovelace, April, 1709, *NJA*, III, 69-81; 390-415. Cornbury charged that "Mr. Morris is one of those who have endeavoured to possess the people here, that they have a right to have Generall Assemblys, and that the Assemblys in these Collonys, have the same Priviledges, Powers, and Authoritys, as the House of Commons in England." Since he was excluded from council or assembly influence, this was a natural position for him to adopt.

²²As early as 1705 William Penn described the Governor as "under a very ill circumstance" as the Tory strength in Parliament declined. William Penn to James Logan, n.d. [1705], *Correspondence between William Penn and James Logan* (2 vols., Philadelphia, 1870-72), I, 374-76.

²³For the discussion of Blathwayt's career, see Gertrude A. Jacobsen, *William Blathwayt: A Late Seventeenth Century English Administrator* (New Haven, 1932). More recent articles on Blathwayt, detailing his involvement in English politics are by Stephen Saunders Webb, "William Blathwayt, Imperial Fixer: From Popish Plot to Glorious Revolution," *W&MQ*, third series, XXV (Jan., 1968), 3-21, and "William Blathwayt, Imperial Fixer," *W&MQ*, third series, XXVI (July, 1969), 373-415. Blathwayt gradually lost influence under Anne, and by 1707 he had been ousted from the Board of Trade.

Representatives to that House, and not to intermeddle therein..."²⁴ Application to the Board by some of Morris's London allies brought an order, early in 1706, to reinstate Lewis Morris to the council of the province.²⁵ Clearly the elements of power in English politics were slowly turning against Cornbury, as his uncle's hold on parliamentary affairs declined.

Left without visible support, Cornbury had only one option left to him. A stalemate was reached, in which the Coxe faction controlled the council, while the three restored Quakers enabled the Morris group to dominate the assembly. Given that situation, the Governor called new elections for the spring of 1707. The electoral contest demonstrated the highly sophisticated structure attained by New Jersey's political factions. Morris coordinated an electoral campaign which, in retrospect, had party overtones and which certainly reflected more impressive organization than has been previously recognized. Morris and his lieutenants went about in both East and West Jersey distributing lists of men who should be chosen for the respective divisions, a tactic which the Quakers had already popularized in Pennsylvania.²⁶ The result was a sweeping victory for the Morris-Quaker forces, in which only five Coxe-Cornbury supporters were elected to assembly seats.

Morris and his cohorts lost little time in taking advantage of this opportunity. When the new assembly convened in June of 1707, Morris and Samuel Jennings, the leader of the West Jersey Quakers, ignored revenue proposals, and instead drafted a petition to the Queen, charging Cornbury with corruption, with receiving a £1,500 bribe in 1704, and with having impoverished the colony. The petition ended by "Imploring your Majestie to Relieve them from the oppression they groan under by the arbitrary and illegall [*sic*] practices of his Excellencie."²⁷ The tenuousness of

²⁴Board of Trade to Cornbury, 20 April 1705, *NJA*, III, 99-100. This injunction was amplified early in 1706, when the Board again chided the Governor in this matter, and concluded with a warning "to be careful in preserving such Privileges of the Assembly, as are belonging to them," Board of Trade to Cornbury, 4 February 1705/6, *NJA*, III, 124-29.

²⁵Board of Trade to Governor Cornbury, 4 February 1706, *ibid.*, 124-29. Morris's case had been "apply's to by some of the Proprietors his Friends, Men of Credit and Estate here," (probably Lane and Docminique of the West Jersey Society).

²⁶Colonel Robert Quarry to the Board of Trade, 28 June 1707 [HSP transcript], P.R.O., C.O. 324/9/pp. 193-99. Morris and his cohorts promised that if supported, "there should be no money raised for the support of Government, nor any Militia Act past [*sic*]." The men whose names appeared on the "lists" it was assured, would so vote if elected.

²⁷Petition of the General Assembly to the Queen, 5 May 1707, East Jersey MSS., no. 28, New Jersey Historical Society, Newark. Cornbury subsequently denied receipt of the bribe, and indeed, there is no evidence that he received one. The charge is merely symptomatic of the period's penchant for overblown rhetoric.

Governors, Politicians, and Sources of Instability

Cornbury's support at home was now well known, and clearly Morris and his supporters meant to take advantage of it in order either to bring Cornbury into line or ruin and discredit him. By 1707 it was evident that the proprietary struggle between the two groups or proprietary interests could not be won under the existing *status quo*, and the Morris forces had set out to establish their proprietary predominance by crushing Cornbury, who had adopted their opponents as his allies.

This petition proved only the beginning, for in October of 1707 New York's colonial agent, John Champante, wrote to that colony, suggesting that Cornbury had little support in London, and that more intensive attacks would probably cause the ministry to forget that he was the Queen's cousin.²⁸ Morris was quick to respond, and in a letter to the Earl of Sunderland, written early in 1708, he suggested that Cornbury's entire life had been one of dishonor and a distinct lack of virtue. The charges degenerated even further, as the Governor was accused of "dressing publickly in women's cloths every day and putting a stop to all publique business" in the process.²⁹

Nor was the process of undermining Cornbury confined to the secular realm. The Society for the Propagation of the Gospel in Foreign Parts, which was founded in 1702 to promote the spread of the Anglican faith in non-Anglican portions of the empire, proved a convenient vehicle for political attack, particularly between 1705 and 1720, when the High Church ascendance in England made it politically expedient for men to use religion against competitors.³⁰ The Anglican clergy in New Jersey split between the two factions, since Morris, Cornbury and Coxe were all leading Anglicans. Morris finally succeeded in driving opposition clerics out of New Jersey, and in concert with the remainder organized an attack on Cornbury. The object, of course, was to undermine the confidence in him of the influential Bishop of London, Henry Compton, who had considerable

²⁸John Champante to Roger Mompesson, 10 October 1707, Rawlinson MSS., Bodleian Library, Oxford, A, 272, f. 237. Champante told Mompesson, a Morris cohort, that "ye more gents ye complain ye better for it will of greater force here."

²⁹Lewis Morris to the Earl of Sunderland, 9 February 1707/8, *NJA*, III, 274-85. Morris also accused the Governor of "prostituting his reputation and fall[ing] victim to an avaritions [*sic*] temper, stooping to sordid measures for gaine, become[ing] the murchandize [*sic*] of factions and price of the highest bidder..." Lewis Morris's statement to Secretary John Chamberlayne (of the Society for the Propagation of the Gospel in Foreign Parts) on the state of the [Anglican] Church in New York and New Jersey, 30 May 1709, The Papers of the Society for the Propagation of the Gospel in Foreign Parts, Letter Books in three series, Series C/Am, I, no. 2. (Hereafter referred to as SPG Letterbooks).

³⁰For a cogent discussion of religion and politics see Carl Bridenbaugh, *Mitre and Sceptre, Transatlantic Faiths, Ideas, Personalities, and Politics 1689-1775* (New York, 1962).

influence with men in high places.³¹

Those manifold pressures finally had their effect. Lord Cornbury had been under fire in London for some time, and by 1708 he had simply run out of influence. His uncle, Lord Rochester, had fallen from power and his father, the Earl of Clarendon, was aged and without influence. Devoid of support, and under steady pressure from men whose connections had materially improved in the previous two years, the Governor awaited the inevitable, and on March 28, 1708 it came. The Queen appointed John Lovelace, Baron of Hurley, as Cornbury's successor, and on April 20 she wrote her cousin, informing him of her decision and ordering him to remain until Lovelace's arrival, and then return to England.³²

Cornbury, discredited as a political force, could only return home in an attempt to justify himself. Yet, this too was denied him. Early in 1709, he was arrested on a spurious charge of failure to repay a debt, in an effort to discredit not only the Governor, but all of those with whom he had been allied.³³ Morris and his colleagues, of course, were not content with ridding the province of Cornbury. They hoped to ruin Coxe, Sonmans and their supporters as well. In this Morris failed, but he had succeeded in exploiting Cornbury's weakness in London politics and had seen that impediment to his ambitions removed from office.

Under different conditions Cornbury might have been a successful governor. Many of the charges levelled against him must be understood in the context of the political invective which pervaded the period. The governor faced a difficult situation, but his greatest failing as a colonial administrator was his political loyalty to the faction which his father had recommended, and the political rigidity which that loyalty engendered. Cornbury, it must be said, maintained long-standing alliances in the colony after it had become obvious that to continue so

³¹Robert Quarry to the Lord Bishop of London, 20 January 1707/8; Caleb Heathcote to Secretary John Chamberlayne, 2 letters, 18 December and 24 December 1707; Reverend John Talbot to Secretary Chamberlayne, 13 December 1707, 10 January 1707/8, and 20 August 1708, SPG Letterbooks, series A, IV, no. 36; series A, III, nos. 161 and 162; series A, III, nos. 158, 172, 173, and 184.

³²Earl of Sunderland to the Council of Trade and Plantations, 28 March 1708, *CSPC,AWI*, 1706-08, p. 711; The Queen of Cornbury, 20 April 1708, *CSPC,AWI*, 1706-08, p. 720; Sunderland to Cornbury, P.R.O., C.O. 5/210/f.48-9.

³³Cornbury's account of 'what I am accused of and my Answers,' 9 March 1708/9, British Museum, Add. MSS., [L.C. Transcript], Hyde papers and correspondence, 15895, fo. 347-50; Cornbury to _____, 9 March 1708/9, British Museum, Add. MSS., 15895, ff. 344-45, 354-55, f. 339-43. Cornbury was charged with converting the public revenue to his own use, with embezzling public taxes and soldiers' pay, with taking bribes in judicial cases, and with attempting to leave the province with a sizeable portion of this money. He denied all of these allegations.

Governors, Politicians, and Sources of Instability

doing was to jeopardize his own government. His inability to incorporate the Morris-Quaker faction into the government in such a way as to secure its support in legislative matters, coupled with his own weakness after 1705 with the home government, proved his undoing.

Indeed, the fact that only nine acts were passed during the Governor's administration is more a testimony to his own political ineptness than to any deep-seated revulsion for him on the part of the populace. For the general citizenry took little interest in politics. This was left to the provincial gentry, and Cornbury failed to win the support and cooperation of significant members of this ruling group. Failing in this, and handicapped by a transitory and often illusory support in the home government, Cornbury was probably foredoomed to failure.

The career of Edward Hyde, Lord Cornbury, adequately serves to demonstrate the nature of American colonial politics in the early eighteenth century. It was within this framework that politics was conducted during the first thirty years of the century. It was not until about 1730, when the Duke of Newcastle's hold on colonial patronage became so thoroughgoing that only the most unusual of circumstances could reverse his decisions, that this diffused and uncertain political structure was significantly stratified.

The experience of New Jersey under royal government does have broader applicability. Political maturity certainly was wanting in the Jerseys. Factions were structured on the personal pretensions of ambitious men, and the issues, such as they were, had very little relevance for the empire, or for the making of imperial policy. Local in scope, factions and issues tended to change suddenly, as the talented, wealthy and well-born men who dominated provincial politics clashed among themselves. Yet despite this parochialism in New Jersey's politics, the reality of the imperial connection had a profound impact on the colony's politics. For the struggle for place and preferment in New Jersey was, of necessity, conducted with or against the governor, and this, in turn affected imperial administration. The inescapable conclusion of this study is that despite a plethora of local issues and personal antagonisms the political history of New Jersey was in reality inextricably tied to the seat of ultimate authority in the English colonial world--to Whitehall and the administrators and politicians who ultimately controlled the outcome of major political events in the colonies.

VALUE ISSUES IN SOCIOLOGY AND SCIENCE GENERALLY

Chester W. Hartwig
Department of Sociology
Auburn University, Auburn, Alabama

Almost fourteen years ago I addressed this Academy on the problematic aspect of the concept of value in sociology. Indeed, as I indicated my view at that time, the concept of value is problematic in all scientific work. In the intervening period I have dealt with the problem of value, directly and peripherally, a number of times hoping to entice others to give due attention to a widely ignored facet of their professional work. Now, a more pressing set of circumstances--revolt of a younger generation, reperception of the limits and condition of our storehouse planet Earth, lemming-like proliferation of the human species, lingering worries about nuclear confrontation, crime in the streets and in high places, persistence of international conflict, internal disputations in our society over racial and sexual discrimination, reawakening to the presence of poverty amidst widespread affluence, and still other claimed-ills of man in our time--has brought into existence a socio-cultural condition raising the value issue to a new prominence in our social sciences and these value issues have implications for all science. Today, in science, we ask ourselves (as did Max Weber in sociology with such unsatisfactory results): What shall we do and how shall we live?

Fundamentally, this is the most important question, as scientist or otherwise, that man addresses to himself. Inherent in the question is the problem of what values, individually and collectively, we should hold and pursue. The problematic aspects of the human condition in our day--the pressing set of circumstances referred to--raises this issue of alternative values, if seriously entertained, in agonizing contexts one after another. When we honestly look to today's circumstance, for instance the questioning and revolt of a younger generation as in sociology where the continuing professional group and its pursuits generally is derogatorily labelled as "Establishment Sociology", it may be tempting to brush the unpleasantries and inconveniences aside with disdain or impatience. If we recall our past, however, we may recognize a familiar and terribly profound issue in human existence that has been resolved again and again--and again, once again, we are being asked to resolve it for our time and place in the vast panorama of human existence. You will not ask me, I am sure, to provide you with a definitive answer to such a profound issue either for myself, for you, or for the whole of mankind. We have here, nevertheless, an inescapable issue that confronts all men and men of science too. That which I address here, the concept of value, does bear directly on this issue of what we do and how we live, including what we do and how we live in the house of science. The value concept and issue has not been satisfactorily resolved in our sciences today.

That all is not well in our science household should surprise no one. We know, certainly, that science is a social pursuit taking place in a socio-cultural setting. We know, surely, of the vital interrelationships between the household of science and the other households within which men dwell. We know, unquestionably, that which Keynes informed us of:

Value Issues

"Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back."¹ We must know--how could it be otherwise particularly in light of the depravations of the sociologist of knowledge--of these vital household interconnections and the interconnections within the household of science when Berger and Luckmann write: "...the present interest on the part of social scientists in theories derived from psycho-analysis would take on a very different coloration as soon as these theories were not regarded, positively or negatively, as propositions of 'science,' but analyzed as legitimations of a very peculiar and probably highly significant construction of reality in modern society. Such analysis, of course, would bracket the question of the 'scientific validity' of these theories and simply look upon them as data for an understanding of the subjective and objective reality from which they emerged and which, in turn, they influence."² We know, only too well do we know, that the anxieties and agonies of the modern scientist are not alone of his doing--his household is a garrison household, and within the garrison household itself is doubt, confusion, controversy and internecine war.

In a recent issue of *Science*, Lewis M. Branscomb addresses himself to the topic of science and its application, technology, in our country where he sees many persons perilously close to regarding rationality as a dangerous guide to human choices because of their doubts about modern science. He noted: "In the first two decades since the war, we physicists were the ones with bad consciences about the social impact of science;" and, in looking to the present situation, he wrote: "Astrology is booming; there are three professional astrologers in this country for every astronomer. I don't know what the phrase 'Age of Aquarius' means, but we are apparently in it, and I don't think I'm going to like it."³

The pages of *Sociological Inquiry* recently provided a room in the science household for the exercising of a violent confrontation of disparate views within the field of sociology.⁴ When the strident struggle ceased, spread across the journal pages were the remnants and reminders of the sociologists' past few decades' *modus vivendi* of the limited recognition of the sociologists' value involvements. Notable, amidst the household debris, was the absence of an in-depth consideration of the nature of the concept of value. Charge and counter-charge of value commitments littered the room; but the possibility of value resolution, like dust and smoke, drifted over the carnage and evaporated into the stillness following on an irresolute struggle onto death and futility.

We must, considering the pressures and imperatives of our time, do better than arrive at Max Weber's stopping place, based on his views that ultimate values led us to that end-point where we too have to proclaim: "Here I stand; I can do no other."⁵ Indeed, such a stand, as Weber compassionately noted, is "genuinely human and moving"; however we live, and must live, in the time of another "human" than the one Weber knew, but a human (including the scientist) which he anticipated.

In the closing portions of Weber's discussion of objectivity in the

social sciences, noting the presence of the fact-greedy gullets of subject matter specialists and the intellectual subtleties of the interpretative specialists--these are C. Wright Mills' abstracted empiricists and grand theorists and others' similar characterizations of scientists, Weber contends these researchers function in a context where they have lost sight of their activity and the object of their research as being rooted in ultimate value-ideas. Then, he continues:

But there comes a moment when the atmosphere changes. The significance of the unreflectively utilized viewpoints becomes uncertain and the road is lost in the twilight. The light of the great cultural problems moves on. The science too prepares to change its standpoint and its analytical apparatus and to view the streams of events from the heights of thought.⁶

Following this is a passage from *Faust* depicting the appearance of a new inspirational insight for man in the awesome presence of the cosmos which Weber contends are "those stars which alone are able to give meaning and direction" to the scientist's labors.

Today we are in such a period where we become "uncertain and the road is lost in the twilight." For the scientist the illumination provided by the star of an earlier time's human-present fades and fails to provide sufficient light to illumine the garrison household of science--to say nothing of those outside science, especially the young, who see no illumination provided by the scientist's star for their problems. Needed once again is a star of sufficient magnitude to reestablish "meaning and direction" for the daily household scientific routines. The star we seek, as I appraise the situation, is a permanent but moving star, consonant with the history of modern science and its development, a star which is to be found in a value-amplified science star with its interpretative power for the understanding of human existence.

Weber was aware of the existence of this star as when he differentiated between formal rationality and substantive rationality and in his distinguishing between formal justice and substantive justice. As he wrote on rationality as related to value:

The concept of substantive rationality is full of difficulties.... Substantive rationality cannot be measured in terms of formal calculation alone, but also involves a relation to the absolute values or to the content of the particular ends to which it is oriented. In principle, there is an indefinite number of possible standards of value which are "rational" in this sense.⁷

In his distinguishing of formal from substantive justice, Weber, in the context of discussing the formalities and rationality of bureaucratic administration, writes:

If, however, an "ethos"--not to speak of instincts--

Value Issues

takes hold of the masses on some individual question, it postulates *substantive* justice oriented toward some concrete instance and person; and such an "ethos" will unavoidably collide with the formalism and rule-bound and cool "matter-of-factness" of bureaucratic administration. For this reason, the ethos must emotionally reject what reason demands.⁸

Substantive justice, or Kadi-justice, is ethical justice; it is grounded in "concrete ethical or other practical valuations."

In still another poignant setting Weber indicated his conviction that "...the ultimately possible attitudes toward life are irreconcilable, and hence their struggle can never be brought to a final conclusion." Weber noted that presuppositions exist in science and theology, but for the religious virtuoso there is an "intellectual sacrifice" and the "tension between the value spheres of 'science' and the sphere of 'the holy' is unbridgeable."⁹ With this appraisal of the nature of the scientific "star" of Weber's we would not raise a question other than when in the course of human events the value-amplified science star appears in the firmament. Weber quite rightly saw the value-judgement households within which men dwell as being in irreconcilable conflict; and, basically, he saw no office for the scientist, for the scientist's intellect and his reality in choosing between ultimate value positions. The scientist's role, for Weber, was restricted to that of the calculation of events, the modes for so doing, and the estimating of consequences following on the holding of alternative values.

But, is this not precisely the significance of science in the modern world? If, and of course it is a profound if--if we grant with Susanne K. Langer that:

The modern mind is an incredible complex of impressions and transformations; and its product is a fabric of meanings that would make the most elaborate dream of the most ambitious tapestry-weaver look like a mat. The warp of that fabric consists of what we call "data", the *signs* to which experience has conditioned us to attend, and upon which we act often without conscious ideation. The woof is symbolism. Out of signs and symbols we weave our tissue of "reality."¹⁰

Or, similarly, if we accede to Berger and Luckmann's human reality as being a socially constructed reality, as they describe it:

Man is biologically predestined to construct and to inhabit a world with others. This world becomes for him the dominant and definitive reality. Its limits are set by nature, but once constructed, this world acts back upon nature. In the dialectic between nature and the socially constructed world the human organism itself is transformed. In this same dialectic man produces reality and thereby produces himself.¹¹

We need remember, then, every man in all human time is an intellectual with varying intellectual capabilities but where his very intellectualism distinguishes him as being human. For human conduct in our day, the informed intellectual has a vast range of human acts and consequences with which to confront the justification of his conclusions of what he considers to be his reality, including his own being, and the reasonable thing to do, the appropriate way to live in view of his realities. Certainly a sober appraisal of cosmic history, a searching scrutiny of the "immense journey of life" (Loren Eiseley's term), and the "study of man" through the ages (Ralph Linton's phrase) provides no pattern for what must be done or what inevitably will be separate and apart from man's constructions out of his experiences. As we look over the available record of man, of his experiences and evaluations of those experiences, can we hesitate for long and disagree with Dewey's estimation of the significance of science for human affairs, and specifically in the realm of what Weber established as a value reserve beyond the purview of science? John Dewey asks:

Is there an impassable gulf between science and morals?
Or are principles and general truths in morals of the same kind as in science--namely, working hypotheses that on one hand condense results of continued prior experience and inquiry, and on the other hand direct further fruitful inquiry whose conclusions in turn test and develop for further use the working principles used?¹²

The revolutionary inference of such a question and implied proposal should not be obscured or ignored. It implies no less than the extension of the method of science for the securing of what it regards as knowledge into the realm of morals, into the realm of value-judgements. It proposes, in effect, an expansion of the symbolic household of science so as to include that which Weber specifically excluded. It does so, basically, by claiming that those who dwell outside the symbolic household of modern science--adequately understood, from the position taken here--fail to adequately comprehend themselves as human beings in the modern world. If and when they do come to understand themselves, they too will be residents in the house of science in the making of value-judgements.

It might be well to call your attention to a specific instance of a stand taken in the Weber tradition, and by one who today is embraced by the group opposed to traditional or establishment sociology: C. Wright Mills. In his admirable *The Sociological Imagination*, Mills writes:

We cannot deduce--Hume's celebrated dictum runs--how we ought to act from what we believe is. Neither can we deduce how anyone else ought to act from how we believe we ought to act. In the end, if the end comes, we just have to beat those who disagree with us over the head; let us hope the end comes seldom. In the meantime, being as reasonable as we are able to be, we ought all to argue.¹³

The critical theme of value difference and hopes for value resolution

Value Issues

is directly related to the conceptualization of value held. The position taken by Mills is not at variance from Weber's for, as he wrote:

"Scientific pleading" is meaningless in principle because the various value spheres of the world stand in irreconcilable conflict with each other....I do not know how one might wish to decide "scientifically" the value of French and German culture; for here, too, different gods struggle with one another, now and for all times to come.¹⁴

The only difference is where Mills' gods beat one another over the head or argue interminably, Weber's gods struggle "for all times to come."

Now, you may charge: we have heard this argument before--and in sociology as well. This is Comte's positivism. Not quite. It is, rather, as Ernest Becker has recently noted in his account of Albion Small's ambiguous career in early American sociology, the dream of the Enlightenment for a unified social science or the intent of Lester F. Ward's "telic" or purposeful science.¹⁵ As in Small's sociology, where he purchases a measure of respectability for this new science in American society by minimizing its involvement with and impact on values in the existent social order; so has sociology won its way, won a measure of acceptance, in society by stressing its objectivity, its value neutrality and frequently, knowingly or unknowingly, by minimizing its vital connection with human values.

It was Harry Alpert, writing in a 1958 issue of the *American Sociological Review* on the 1946 Congressional struggle to win federal support for basic social science research through the to-be-established National Science Foundation, who stated: "A social science program within the general framework of scientific objectives can properly be limited to the hard-core scientific end of the continuum."¹⁶ In effect, this was a way of saying to potential supporters of fundamental research in the social sciences, including sociology, you need not worry about the social scientist raising embarrassing ethical, philosophical, political, economic, religious and other vital issues for the social scientist can restrict himself to hard facts, and who can possibly be embarrassed by hard facts? That Alpert was well aware of the societal context in which he was involved is made plain by a later comment in his report, where he noted:

The sociologist of science will one day marvel at the extent, variety, and depth of the resistances to the application of rational intelligence and scientific method to the understanding of the nature of man's social behavior. And a latter-day Vilfredo Pareto, with some psychiatric sophistication, will delight in recording the derivations and rationalizations which man has invented to keep himself from a better understanding of his own nature and his social environment.¹⁷

I am tempted--though making no claim for being a latter-day Pareto--to

take delight, mingled with dismay, in noting the derivations and rationalizations employed by scientists to keep themselves from noting the revolutionary import of their activities and findings not only for their society but for a better understanding of their own nature and activities as scientists.

Alpert had another opportunity to become acquainted with the scandalous conceptualization of science that tends to prevail in this country epitomized in our use of the term "natural sciences" as distinguishable from our other scientific pursuits called the social sciences. One wonders if by this we intend to convey the notion that our social sciences are somehow "unnatural." This may in some measure be the case, for Alpert had the distinction of being one of the very few social or behavioral (this recent distinction will not be argued here) scientists invited to participate in a 1959 national Symposium on basic scientific research sponsored by no less than The National Academy of Sciences, The American Association for the Advancement of Science, and the Alfred P. Sloan Foundation. In the preface to the report on this Symposium Warren Weaver records receiving "several stirring communications" which, as he summarized them, protested:

Why did the Symposium not include a proper emphasis on the social--or more particularly, the behavioral--sciences? You speak of basic research and seem to assume that this phrase is restricted to the quantitative and analytical natural sciences! Why do you not include, in addition to the social sciences, the humanities, the fine arts, and the philosophical and moral nature of man?¹⁸

Weaver's response to these protestors was: "With respect to the behavioral, or even more generally the social, sciences it can, I think, be soundly argued that the Symposium did actually not neglect them." It can, and was, argued, but not soundly. In my view, at a conference concerned with basic scientific research, made up of about 450 participants, where the conference is overwhelmingly dominated by business, industrial, and governmental figures (including then President Eisenhower) and science represented by physical and biological scientists with hardly a sprinkling of behavioral scientists, there is a good chance that despite their good intentions for being concerned with "basic research in our country" or "problems general to all scientific work" such a group does not contain within itself the expertise and sensitivity of the social scientist and the humanities with regard to the difficulties and problems of carrying on basic research in these areas, nor does such a group comprehend the meaning and significance of social scientific work and achievements for the object of their study, man and society. For good measure, it can be confidently asserted that the prospects are good that such a group will possess an impoverished understanding, in the wider sense, of their own scientific work, their own character, and the implications for man and society of their knowledge achievements.

Too long, in the West, have we presumed that the pursuit of science and offspring, technology, would result in nothing but social good. We

Value Issues

have assumed, essentially, that we were involved with a simple process which inevitably preserved a society's basic structure and expedited the securing of that society's basic values. Only when we stood on the edge of nuclear confrontation and universal human disaster, only when we came to appreciate our potential for seering and sweeping from the surface of the earth the whole of the human species, did we pause to ask ourselves with some felt measure of horror: what are we doing and what are we about to do? Along the way in the development of our social sciences we have had an occasional troubled figure to pause and consider the meaning of our accumulating social knowledge and our newly-won potential for the reshaping of society and its participants. Only recently in this country, within the social sciences as well as elsewhere, have we had a significantly large group, on the basis of their perception of themselves and their society's structure and values including the presence of "objective" social science, raise the question with earnestness and sincerity: what are we doing and what are we about to do? Science needs, possibly desperately needs, to look at the concept of value and discern its relevance for those in, and out of, the house of science.

FOOTNOTES

¹Cited in Robert L. Heilbroner, *The Worldly Philosophers* (New York, Simon and Schuster, 1953), p. 4.

²Peter L. Berger and Thomas Luckmann, *The Social Construction of Reality* (New York, Doubleday, 1966), p. 172.

³Lewis M. Branscomb, "Taming Technology," *Science*, March 12, 1971, p. 972.

⁴Winter, 1970 issue.

⁵H. H. Gerth and C. Wright Mills, *From Max Weber: Essays in Sociology* (New York, Oxford University Press, 1946), p. 127.

⁶Max Weber, *The Methodology of the Social Sciences* (Glencoe, Free Press, 1949), p. 112.

⁷A. M. Henderson and Talcott Parsons (trans.), *Max Weber: The Theory of Social and Economic Organization*, edit. with introd. by T. Parsons, (New York, Oxford University Press, 1947), p. 185.

⁸Gerth, Mills, *op. cit.*, p. 220-21.

⁹*Ibid.*, p. 154.

¹⁰Susanne K. Langer, *Philosophy in a New Key* (New York, Penguin, 1948), p. 227.

¹¹Berger, Luckmann, *op. cit.*, p. 168.

¹²John Dewey, *Problems of Men* (New York, Philosophical Library, 1946), p. 156.

¹³C. Wright Mills, *The Sociological Imagination* (New York, Oxford University Press, 1959), p. 77.

¹⁴Gerth, Mills, *op. cit.*, p. 147-48.

¹⁵Ernest Becker, *The Lost Science of Man* (New York, George Braziller, 1971), p. 31.

¹⁶Harry Alpert, "Congressmen, Social Scientists, and Attitudes Toward Federal Support of Social Science Research," *American Sociological Review*, December, 1958, p. 685.

¹⁷*Ibid.*, p. 686.

¹⁸Dael Wolfle (ed.), *Symposium on Basic Research* (Washington, AAAS, 1959), p. xvi.

Maicoba, Village in Mexico

MAICOPA: A VILLAGE TO BE STUDIED DISTRICT OF YECORA, SONORA, MEXICO

Margaret Z. Searcy
Department of Anthropology
University of Alabama, University

The Maicobans of the Baja Piman stock are a little known group of Indians which is fast nearing extinction. Those who leave the area soon lose their tribal identity; those who stay are rapidly dying out. They are located in a remote valley (108°55'W, 28°23'N) in the Sierra Madre Occidental, Sonora, Mexico, which formerly could be reached only by a very difficult journey through the deserts and mountains. The primary concentration of Indians is at Maicoba in the District of Yecora at an elevation of 4,730 ft. Yecora is also the name of the largest village (252 inhabitants) in this sparsely populated area. Today, air transport connects Yecora with the outside world on Monday, Wednesday and Friday, but the fare of 150 pesos and the six-passenger airplane limit this method of transportation to army officers, Mexican civil authorities and a few church fathers. The small village of Maicoba is approximately 23 kilometers from Yecora. This journey entails 2 hours and 30 minutes of hard travel by a four-wheel drive vehicle over a newly completed road. Men who leave, hopefully, to find jobs as migrant farm workers on the cotton plantations or other large irrigated farms in the northwest use a burro or two strong legs as their mode of transportation.

Cabeza de Vaca in 1540 was the first Spaniard to come into the region. He recruited several hundred discontented Baja Pima, including women, some of whom became wives for his Spanish followers, and he founded a colony called Bamoa on the Sinola River to the south. Contact with the natives in Yecora continued, and the genes of the Spaniards found their way into the gene pool. Little by little, more Spaniards came into the area - soldiers, priests, colonizers. Missions were established throughout Sonora, but even the Catholic Church neglected Yecora long after other nearby missions were flourishing. Maicoba finally got its church in 1676. In recent years, the priest has come only one week out of the year. In the last few years he has not come at all.

From time to time, feuds, fights, and revolts swept the region. The Baja Pima Indians were too poor to participate in any real warfare. They were followers, never leaders, whenever a widespread revolt occurred. As a whole, they were peaceful farmers and gatherers who were left alone by the Spaniards.

Today the people of the area are so poor and hostile that the civil authorities will not even take their pistols off to go to bed, and strangers are warned repeatedly never to go into the region unarmed. The natives bar their windows and doors before retiring for the night. In 1968 and 1969 political unrest was felt throughout Mexico and especially in Sonora, which was suffering from an unusually severe drought. Signs appeared on buildings and at the roadsides campaigning for PAN, the opposition party to the controlling party, PRI. Signs were usually splashed with red paint representing "bread and blood". The poor

mountain villages in Yecora were among those which needed bread the most. One tortilla a day, little else, was the usual fare for the average peasant in the summer of 1969. Thousands of hungry natives migrated from Sonora and the adjacent states to crowd the large cities of Durango and Ciudad Obregon in hopes of finding food and work. The whole area was ripe for a revolution, and isolated mountain villages made good centers for the insurrectionists.

Maicoba was singled out as a trouble center and government officials decided for reasons of civil defense that good roads must be built through this area. The Maicobans had been asking for a road for more than twenty years, but in the past road building had not been a sound economic investment. Even though individual citizens gave work to the community in lieu of taxes, road building in the Sierra Madres was beyond their capabilities. Now this project became the task of the Mexican Army and the soldiers actually were the construction workers.

A few socio-economic facts taken from the 1960 Mexican census will help to clarify the life style of the Yecorans: 3,404 people, out of a total population of 5,323 in the whole District, lived in 587 adobe houses; 1,760 lived in 313 wooden structures; 40 individuals lived in eight brick dwellings; and 68 inhabited homes made of tree branches and tar paper. Only 11 houses had water inside; one had a bathtub inside and two had tubs outside; 15 had outside toilets, the others had none; 5,249 people had no water in the house. All of the houses were small: 332 dwellings, housing 1,760 persons, had one room; 332 homes had two rooms and housed 1,818; and 153 three-room structures housed 1,885. There were no large homes. Radios were owned by 115, but many of the owners spoke only a few words of Spanish and enjoyed only the music. Two television receivers were reported.

In Mexico the generally accepted way of determining the number of indios in the population is to list the number of inhabitants who speak a language other than Spanish as the first language. Most of the inhabitants in Yecora could not fill in the census form and the census taker erroneously listed all the natives as being Spanish-speaking people. A majority of 4,951 were reported to be Catholic. Two other questions in the census throw light on the problem of ethnic identity: 562 persons answered that they ate no wheat bread, only corn products; 562 inhabitants wore no shoes, while 1,031 wore only huaraches. Some of the indios wear handmade low boots of cowhide. The figures are not conclusive. The wife of El Presidente de Maicoba (local usage) stated that the real test can be made by looking at the houses. The indios do not grow pot plants, the hispanos and mestizos do.

Maicoba, one of the poorest villages, has very few pot plants. The wife of El Presidente has a row of flower pots across her veranda. She has the only house in the village which has wooden floors in two rooms; her dirt kitchen floor must be sprinkled with water to settle the dust. She has in her backyard the only well and, located by the well, the village's only toilet. One dirty water hole serves animals and most villagers as the only source of water. Washing is done only when it rains. There is no electricity or telephone. In the winter the

Maicoba, Village in Mexico

temperature may drop below 0°C, but the only source of heat is from pino wood which is scarce and must be brought in over the steep mountain trails. Only 10 houses in the District burn oil and gas.

The majority of the flower pot owners are the patrilineal relatives of El Presidente, who is fortunate enough to have 50 descendants. Although they do not all live in Maicoba, a large enough number remain to elect him to office in a shouting election. The winner of a shouting election is the man whose supporters shout his name loudest for the greatest length of time. It is the job of El Presidente to assist the villagers in their dealings with the civil authorities and to act for the government. Senora, his wife, is the keeper of the keys to the church, a very honored position. El Presidente can read Spanish and he can speak both Spanish and the local language, a form of Piman. Indios do not go to school in Maicoba, only the hispanos and mestizos go. Children customarily start school when they are 10 and stop at the age of 12. There has been no teacher in the village for the last four years and the villagers had no prospects for a teacher.

"Five communist students" plotted against their country in Maicoba and the army had to be summoned. The dangerous "students" were shot during the time of the student riots in Mexico City. Maicoba's population of 105 had been decreased by five, but it increased by 150 while the army was stationed there.

The army tents were erected on the east side of the central square and several adjacent houses were used by army personnel. The church and the empty schoolhouse are on the north, El Presidente's house and several others on the south. Across the square, facing the army tents, are a number of one- and two-room dwellings. Small stores were operated from two houses. A ball court is situated in the center of the square, which occupies the flat valley floor; other homes are scattered around the village.

The soldiers, though quartered ostentatiously in the tents, left one by one, minutes after "Taps" had sounded, to spend the night in the houses of the natives. They returned to the barracks just before "Reveille." Additional hispano, mestizo and other Indian genes and influence from all over Mexico were being added to the population. The General estimated that the road construction project would last at least two years. (A letter received from the Colonel, Antonio Redon Travera, January, 1970, stated that the road was almost completed).

Prior to the arrival of soldiers, the Maicobans had had little to do with outsiders. They had literally crawled on their knees for miles to greet the priest the one week which he customarily spent with them. Indians return to the area from many places, but these are people who belong to the group. The District nurses come once a month, never the doctor. The nurses are treated with respect, but they spend only a day, not an evening, in the town. A linguist from the United States came in the past to try to learn the language but everyone refused to talk to him. A Mexican female physical anthropologist from El Museo de Antropologia y Historia spent a week traveling to Maicoba; she stayed two

days. No one would have anything to do with her. She said that she realized that it would be impossible for her to work in the area. The Maicobans have stopped going to Yecora where the health clinic and the air strip are located.

Letters of introduction from Senator James B. Allen and Congressman Walter Flowers explaining that I had received a research grant from the University of Alabama opened many "closed doors" for me. Vice Consul Robert Stephen Pastorina of the United States arranged with Dr. Gustavo Ayala y Leyva, Chief of the Federal Health Department, for me and my husband and 14-year old daughter to be flown to Maicoba and for us to land in a small plane on a portion of the newly completed military roadway. The fact that my husband and child were along added to my importance, harmlessness and respectability. They were also wonderful observers and I obtained much more data than I ever would have alone. We were extended every courtesy and consideration. Two generals met our plane when it landed. In Mexico young doctors, in order to help defray the cost of their medical education, give two years of service to their country. Two young doctors assisted me greatly; Dr. Yebarra, who was the district health officer, had received orders from Dr. Ayala y Leyva to act as my interpreter, guide and armed protector, and not to leave my side for the duration of my stay. The General assigned Dr. Redon Travera, a Colonel in the Mexican army, to act both as an informant and interpreter with the Pimas. (Dr. Redon Travera had listened to all of Alabama's football games on the Army short-wave radio and he knew all the players). Dr. Yebarra and the Searcys became the houseguests of El Presidente and his wife.

Certainly the method I used is not the way to conduct an ethnographic study and certainly no study can be made in two days. This material is being presented now because, according to Don Deanando y Pesqueria of the University of Hermosillo and the other gentlemen whom I have named, no study has ever been made of the Yecorans and the Maicobans.

I had five chief informants, the doctors, my hostess, whom I shall refer to as "Senora," and the two husbands in a polyandrous Indian household. The Mexican doctors talked freely. One liked the area; one despised it. My hostess told us only those things which she thought would make a good report. For example, in spite of the fact that she knew that we had witnessed the army's mass exodus the previous evening, she said that the soldiers never left the army tents at night. She also told us that no one believes in witchcraft now. She was charming and shared all the food which she had; coffee, a part of a watermelon, some frijoles and tortillas. She had bought a box of soda crackers in our honor. Of course, we had brought canned goods and we shared our food with her. We opened many different kinds so that her hungry grandchildren who had watched the adults eat, could try our food too. One of her sons brought her a sack of potatoes as we were leaving.

The situation in the coursed masonry, bug-infested, one-room home of two Maicoban Indian brothers who shared the polyandrous, patrilineal, virilocal household was far different from the home of El Presidente. The elder brother was the frightened spokesman for the family, and he

Maicoba, Village in Mexico

spent several hours rapidly answering every question which the army colonel translated. Two armed men were standing nearby.

The two Indian brothers had originally married two sisters. Five children had been born to one sister and two to the other. One child from each marriage survived, the others had died as infants. One sister died in childbirth. The remaining woman became the wife of both men and the mother of both children. Only the old grandmother assists the mother in childbirth. Many women and children die because of malnutrition, disease, poor hygienic practices, and other complications. The men outnumber the women and the Indians are dying out. Dr. Yebarra said that to save the lives of the mothers and children would only increase the death rate due to starvation. A mother usually nurses her baby for a period of two to four years. If the mother dies, the young baby usually dies too. No cow's milk is fed to the baby, even though a few cattle are owned and some cheese and butter is made. None of the barefoot population suffers from hookworm; it is too dry for the larval stage of the worm to survive.

The Indian family had only one tortilla apiece to eat on the day of the interview. All of the available wild food in the immediate area had been consumed and the men had killed no deer. Some hunting is done by the men.

Ten- to twelve-year-old children, boys and girls, may go with their fathers to help raise corn, beans, wheat, melons, some garden vegetables and prickly pear fruit. A burro or horse is hitched to a plow to break the land. Land is redistributed every two years by the male's family group; but the informant said that this group is not very strong. This one sentence suggests that the group might have had a patrilineal clan system which was more powerful in the past. My interview ended abruptly when my interpreter was called away because of a bad accident on the road and I had to return to Senora's house to try to learn a few more facts.

The burros and a few pigs and chickens eat all the garbage which is dropped in the village. The animals were even more hungry than the people. When a burro is too old to work, it is made into jerky and eaten. Dried corn and beans constitute the bulk of the winter food. In the winter a man might take a burro into the mountain to look for silver. Little is found, but men keep on searching. A cry, "Ah ha," might announce his return home. The natives enjoy making this happy sound and when one man utters it, often a similar response comes from another male. Men leave home two or three times a year to go to Ciudad Obregon to work in the fields; here they also purchase cloth, clothing and shoes. They make almost everything else which they use. Women do not leave the vicinity of their homes. A girl is usually married by the time she is 12. Males marry between the ages of 18 and 25. Senora said that a man proposes and the girl accepts, but the system is probably not this simple. Divorce is rare. This is an area in which a few people live to be extremely old. The doctors reported cases of two ancient individuals, one was 103 and the other 114.

The ball court and the church serve as the two focal points of village life. The soldiers played ball regularly in the square while they were there. The natives are quite proud of their church and their Virgin and they take her out and parade her around the square regularly. The Virgin is believed to have the power to bring rain and is a protection against hail which is frequent in the area.

"Some people who have had alcohol try to put her down," said Senora, who had unlocked the doors of the seventeenth century typical mission church with its thick adobe walls. The church was gaily decorated with paper flowers. The villagers will not allow anyone to have alcohol in the village now, but this ruling has come about since the soldiers have been quartered here. Hundreds of discarded beer cans by the water hole give mute evidence of drinking parties.

A religious festival is held around October 4 which lasts a little over a week. This is the time when, hopefully, a priest will come. Indios will crawl on their bloody knees for several miles to pay their respect to the Virgin and the saints. They hope that God will have pity on those who suffer. The religious festival in October also has other phases; it is a party, a dance, a time for guitar music and singing, a drinking festival, and a time when former natives return. It is a time of prayer for good weather and a good harvest. Old ties between families are renewed and strengthened. Some people return from as far away as Mexico City, but they are those who have their roots in the village. The nine day ceremony which is held for the dead is another time when the natives return. "Some people who practice the old ways always return from the cities," said Senora.

It is evident from the few facts in this paper that an anthropologist needs to return to Maicoba. The people have an interesting culture which needs to be studied before further acculturation has taken place. For me to have stayed longer in Yecora at the time of my first visit would have been a real imposition on my hosts. Whether or not a person will be able to work in Maicoba after the army leaves is questionable but, perhaps, if one is a teacher...? Maicoba is certainly an interesting place, and the Yecorans are rapidly vanishing people who should be studied.

Maicoba, Village in Mexico



FIGURE 1. Burros returning with wood in Maicoba.

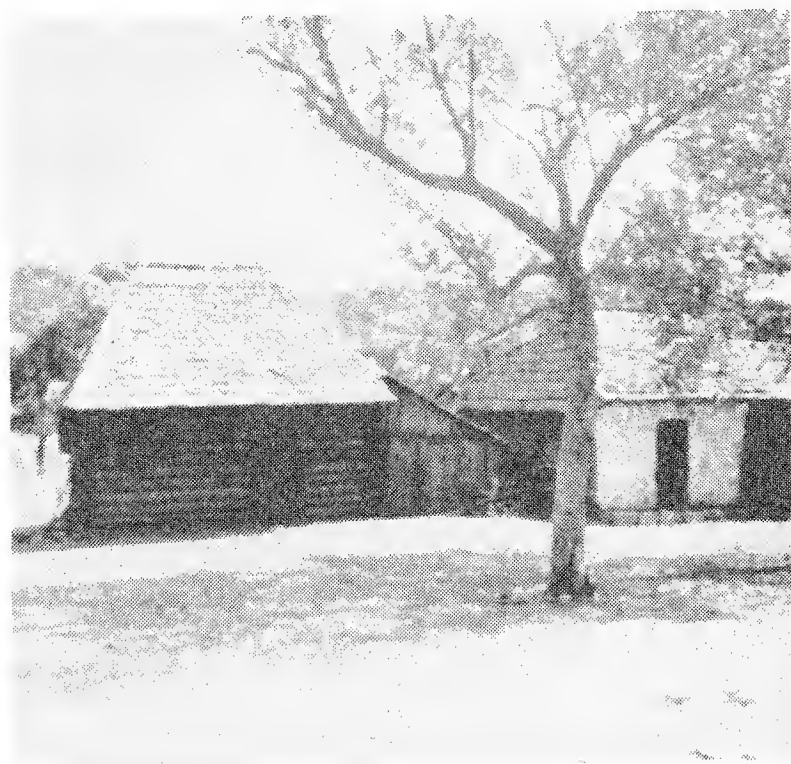


FIGURE 2. The main square in Maicoba.



FIGURE 3. A gate leading to the cactus garden.

Ergasilus wareaglei

ERGASILUS WAREAGLEI SP. N. (COPEPODA:CYCLOPOIDA) FROM
NORTH AMERICAN CATOSTOMID FISHES¹

Sterling K. Johnson
Department of Fisheries and Allied Aquacultures
Auburn University, Auburn, Alabama

The parasitic copepod described herein was taken initially from the gills of a northern hogsucker, *Hypentelium nigricans*, collected from the Tennessee River drainage, Flint River system, Madison County, Alabama. Other specimens from the same host were obtained from the Pascagoula River drainage, Jones and Covington Counties, Mississippi. The Alabama hogsucker, *H. etowanum*, was found to host the new species in the Alabama River drainage, Shelby County, Alabama. The parasites were collected during a survey of fish parasites conducted by the Southeastern Cooperative Fish Disease Project of the Auburn University Agricultural Experiment Station, Auburn, Alabama. Measurements are in microns and exclude setae. Drawings were made with the aid of a Bausch and Lomb Tri-Simplex Microprojector. Specimens were studied in lactic acid and by the method described by Johnson (1969).

Materials:

Ergasilus wareaglei sp. n. (Fig. 1-9): Holotype, USNM Helm coll. no. 72007, and two paratypes USNM Helm coll. no. 72008, from *Hypentelium nigricans* from Burton's Creek, Leaf River Drainage, Covington County, Mississippi.

Additional specimens: 11 specimens from type locality; 8 specimens from *H. nigricans* from Leaf River Drainage, Jones County, Mississippi; 2 specimens from *H. nigricans* from Chickasawhay River Drainage, Clarke County, Mississippi; 16 specimens from *H. nigricans* from Flint River Drainage, Madison County, Alabama; and 5 specimens from *H. etowanum* from Cahaba River Drainage, Shelby County, Alabama.

Location on host:

Gill filaments.

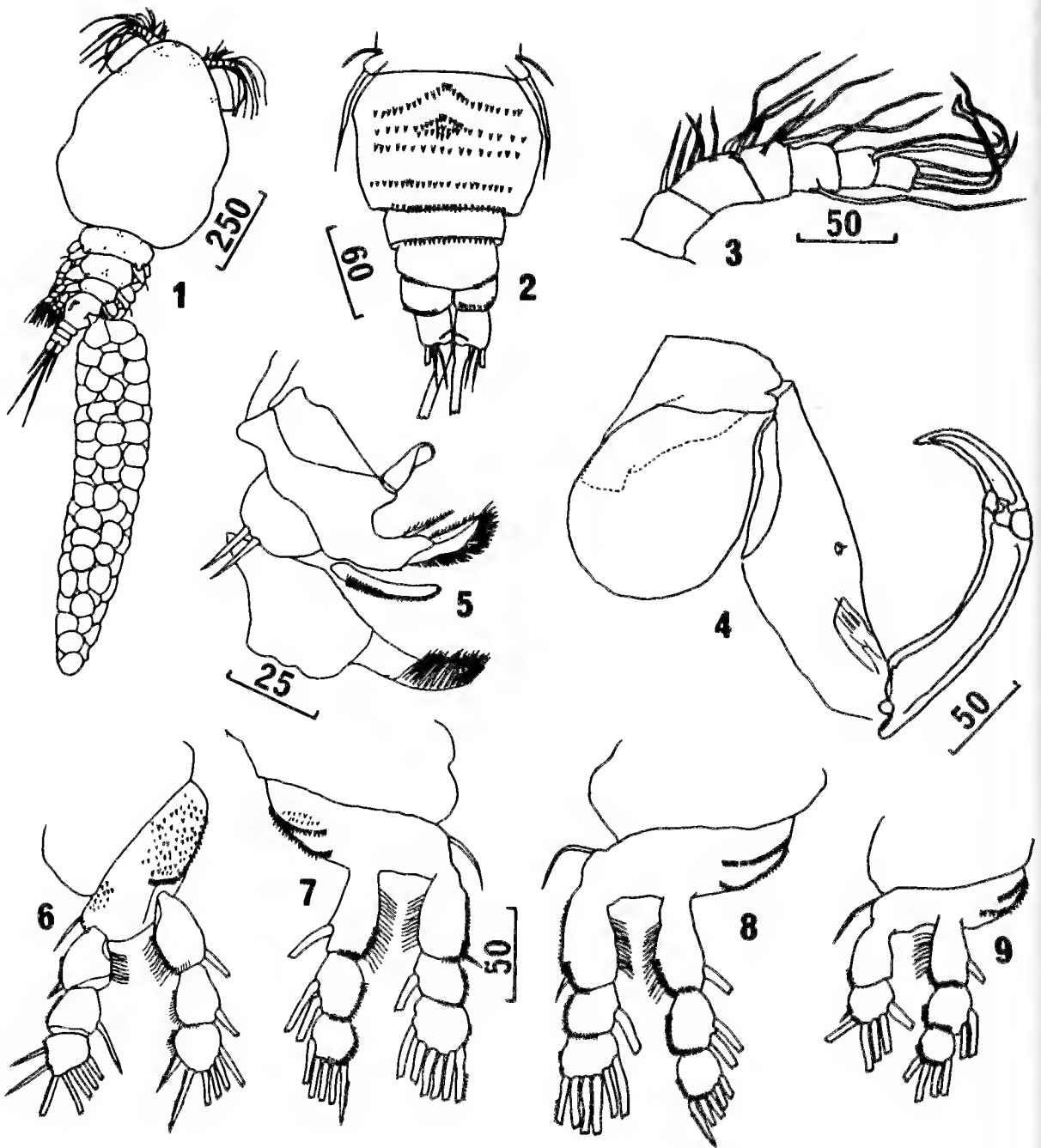
Description:

Female: Total length 1010 μ (800-1200 μ). Carapace inflated, longer than wide. The head and first thoracic segment fused, with an indentation indicating the union. Antennal area inferior, overhung dorsally by inflated portion of carapace.

Free thoracic segments narrowing sequentially with the first being 0.45-0.50 the width of the carapace. Ratio of widths of the four free thoracic segments 6:4:3:2. The first with two posterolateral papillary extensions on the tergum (Fig. 1). Sternites one (fused) two and three with rows of 80-90, 60-70, 35-45 spinules, respectively, arising on posterior edge and projecting backward.

Genital segment a little wider than long with ventral surface decorated with five rows of spinules (Fig. 2). Three abdominal segments

¹Supported by the Southeastern Cooperative Fish Disease Project
(In part by Sport Fish Restoration Funds).



FIGURES 1-9. *Ergasilus wareaglei* from *Hypentelium nigricans* from Leaf River Drainage, Mississippi. 1. Dorsal view of female. 2. Genital segment and abdomen including fifth legs. 3. First antenna. 4. Second antenna. 5. Mouth parts. 6-9. First through fourth legs, all ventral views.

Ergasilus wareaglei

present and each skirted on the posteroventral edge with spinules. The third segment divided.

Caudal rami as wide as long (Fig. 2). Each bears a long seta medially and a short seta laterally on the distal edge and two small setae ventral to these. A row of setules located immediately anterior to the long seta on the ventral surface.

First antennae six segmented with the segments diminishing in size distally (Fig. 3).

Second antennae (Fig. 4) four-jointed (segments 1-4 length ratio 9:20:15:8). Basal segment subcubical with an inflation between it and the second segment. Second segment subrectangular with a sensillum midway on medial margin. Terminal segment unornamented and rather short and curved.

Mouth parts (Fig. 5). Mandible basal segment subrectangular with a terminal spine. Terminal segment plumose, more coarsely beset with bristles on the inside margin. Palp with pectinate inner margin. First maxilla ovoid extension bearing two setae. Second maxilla with large subtriangular basal segment, terminal segment with coarse bristles covering distal end.

Swimming legs (Fig. 2, 6-9). Coxapodites apparently unornamented. Basipodites each with a sensillum and a small seta located dorsally near insertion of exopod. Second, third, and fourth basipods with two parallel rows of setules beginning medially and continuing laterally on ventral surface to a distance approximately $1/3$ basipod width. Unless stated otherwise, all following setae plumose (cilia not shown in figures).

Leg 1 rami (Fig. 6). Exopod 3-jointed. First segment with a small spine on the distolateral surface and long cilia on the medial margin. A short row of spinules just proximal to the spine. Second segment with one long seta on distomedial margin and with a row of spinules on the lateral margin. Third segment with 5 terminal setae and 2 distolateral spines. Most lateral seta slightly shorter than others with serrate outer and plumose inner margin. The third segment lateral margin with a pectinate row beginning proximally and extending ventrally around second spine base. Endopod 3-jointed. The first segment with a seta projecting from the distomedial margin, the outer margin with a row of long cilia and a row of spinules which continue skirting distal edge. The second segment with similar spinule arrangement and distomedial seta. The third segment with 4 setae on the inner margin and two distolateral spines, pectinate on their outer margins and naked on inner margins. A spinule row located proximal to the most lateral spine. Spine setae formula: exopod, I-0, 0-1, II-5; endopod, 0-1, 0-1, II-4.

Leg 2 rami (Fig. 7). Exopod 3-jointed. First segment with a distolateral spine and a row of cilia along inner margin. Just proximal to the spine is a row of coarse spinules. A row of fine spinules beginning at the lateral midpoint and skirting the distal edge. Second segment with spinules on the lateral and distal margins and a seta extending from

the medial margin midpoint. Third segment with 6 terminal setae, the most lateral with pectinate outer and plumose inner margin. Two short spinule rows and lateral segment margin just proximal to the lateral seta. Endopod 3-jointed. First segment with a distomedial seta and a row of cilia on lateral edge. A spinule row beginning at the lateral margin midpoint and skirting the distal edge ventrally. Second segment inner border with two setae subterminally and a spinule row beginning at the lateral surface midpoint and skirting the distal edge. Third segment with a spinule row distally in similar manner and with a distolateral spine and 4 terminal setae. The most lateral seta with a pectinate outer and plumose inner margin. Spine seta formula: exopod, I-0, 0-1, 0-6; endopod, 0-1, 0-2, I-4.

Leg 3 rami (Fig. 8). Essentially the same in structure as rami of leg 2. Exopod and endopod 3-jointed. Spine seta formula: exopod, I-0, 0-1, 0-6; endopod, 0-1, 0-2, I-4.

Leg 4 rami (Fig. 9). Exopod 2-jointed. First segment with a spinule row distolaterally. Second segment with 5 terminal setae and one small lateral spine. Short spinule rows at bases of spine and most lateral seta. Endopod 3-jointed. First segment outer margin with a ciliary row and inner margin with a distomedial seta. A spinule row beginning distolaterally and skirting ventral edge. Second segment similar to first with a skirting spinule row and with two medial setae. Third segment with four terminal setae and a spinule row beginning at lateral margin midpoint and continuing around distal margin on ventral surface. Spine seta formula: exopod, 0-0, I-5; endopod, 0-1, 0-2, 0-4.

Leg 5 (Fig. 2). Papilla with a terminal long seta and a seta arising from papillary base.

Male: Unknown.

Etymology:

I am pleased to name this copepod in honor of the mascot of Auburn University, War Eagle.

Comparisons:

Several North American ergasilids have an obvious spherical inflation at the junction of the first two segments of the second antenna (*E. auritus*, *E. turgidus*, *E. cotti*, *E. luciopercaum*). In all cases, however, there are tooth-like knobs borne on the inner margin of the antenna.

E. wareaglei most closely resembled *E. centrarchidarum* Wright, 1882. In fact, except for the spherical inflation between the first two segments of the second antenna, *E. wareaglei* could be considered *E. centrarchidarum*. However, the author has examined numerous specimens of *E. centrarchidarum* from over 40 localities and has always found them to be without the pronounced inflation that is typical of *E. wareaglei* (Johnson, 1971). In contrast, all specimens of *E. wareaglei* that have been examined possess the spherical inflation.

Ergasilus wareaglei

Results of Wilson (1911, 1916), Tedla and Fernando (1969), Roberts (1970), and Johnson (1971) indicate that centrarchids are the preferred hosts of *E. centrarchidarum*. *E. wareaglei*, as can be seen from this report, prefers catostomids. Voth and Larson (1968) reported *E. confusus* Bere 1936 (= *E. luciopercarum* Henderson 1926) from *Catostomus commersoni* in North Dakota but re-examination of the specimens has shown them to be *E. wareaglei*.

ACKNOWLEDGEMENTS

I wish to thank Dr. W. A. Rogers, Auburn University, for collecting part of the material and giving it to me as part of a copepod collection. Dr. O. R. Larson kindly provided specimens from the University of North Dakota Parasitology Collection.

LITERATURE CITED

- Johnson, S. K. 1969. Sodium hypochlorite: Use on parasitic copepods for identification. Trans. Am. Microscop. Soc. 88:591-592.
- Johnson, S. K. 1971. Distribution of the genus *Ergasilus* (Copepoda: Cyclopoida) in several Gulf of Mexico drainage basins. Ph.D. Dissertation, Auburn University, Auburn, Alabama.
- Roberts, L. S. 1970. *Ergasilus* (Copepoda: Cyclopoida) revision and key to species in North America. Trans. Am. Microscop. Soc. 89:134-161.
- Tedla, S., and C. H. Fernando. 1969. Observations on the biology of *Ergasilus* spp. (Cyclopoida: Copepoda) infesting North American freshwater fishes. Can. J. Zool. 47:405-408.
- Voth, D. R., and O. R. Larson. 1968. Metazoan parasites of some fishes from the Goose River, North Dakota. Am. Midl. Nat. 79:216-224.
- Wilson, C. B. 1911. North American parasitic copepods belonging to the Family Ergasilidae. Proc. U.S. Natl. Mus. 39:263-400.
- Wilson, C. B. 1916. Copepod parasites of fresh-water fishes and their economic relations to mussel glochidia. Bull. U.S. Bur. Fish. 34:331-374.

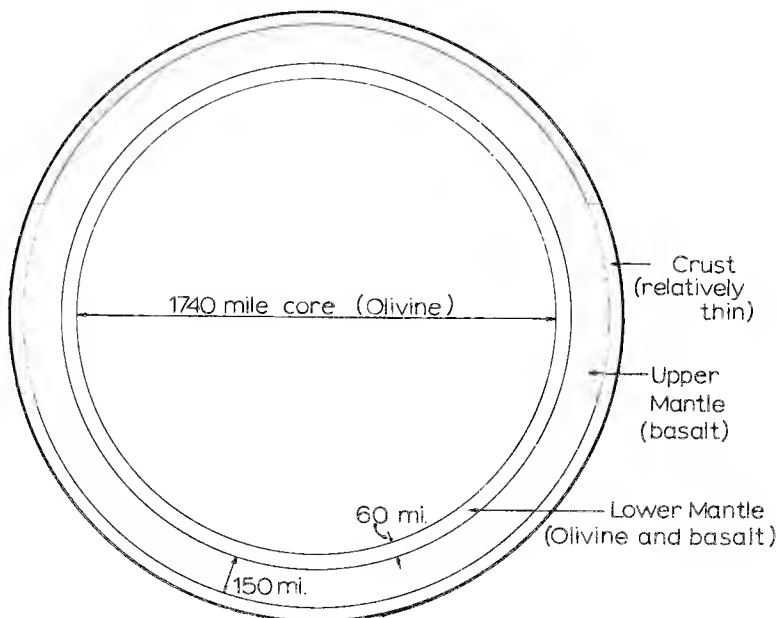
ARE LUNAR ROCKS IGNEOUS IN THE SAME SENSE AS EARTH ROCKS?

Reynold Q. Shotts

Department of Civil and Mineral Engineering
University of Alabama, University

Now that approximately 75 pounds of rocks from each of Apollo 11 and 12 missions have been thoroughly X-rayed, melted, fractionated, magnetized, analyzed, radiated and perhaps even digested, a consensus regarding the structure and history of the lunar body appears to be jelling. Not unexpectedly, it bears remarkable resemblance, with some differences in detail, to the pre-Apollo consensus. This may mean that pre-Apollo remote investigations were correct and are being confirmed or it may mean that our real information is so local and scattered that it still fits into almost any prefabricated theoretical mosaic. Apollo 14 returns from the lighter, more reflective Fra Mauro region may or may not fit into the consensus.

A news item in the science section of *Time*, dated 25 January 1971 and reporting on papers read at the Houston Apollo 12 Lunar Science Conference, states: "The moon, they agreed, is not a cold unchanging conglomerate of material, as originally suspected by some theorists. It is apparently warm inside, has been geologically active and may even be undergoing small surface changes." The article was accompanied by a cut-away photograph of the moon with a dimensioned cross section, Figure 1.



Lunar radius = 1080 miles or 1738 km.

FIGURE 1. Cross section of the moon with compositions and magnitudes for layers. *Time*, January 25, 1971, pp. 42-43.

Lunar Rocks

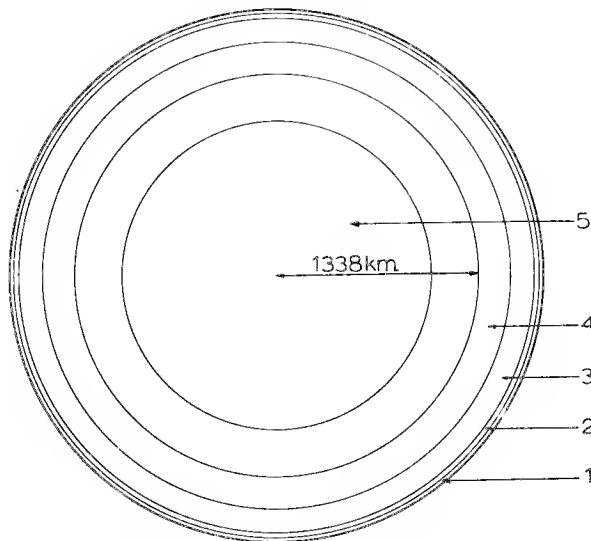
Previous to the early January Lunar Science Conference, there appeared in *Science*, 18 December 1970, "A Summary of Arguments for a Hot Moon" by Ralph B. Baldwin, which discusses a similar "model" for the moon. Figure 2 shows Baldwin's suggested dimensions for a "layered" moon.

From the return of the first moon rocks, they have been generally referred to as "igneous." This probably means merely that they have apparently crystallized from a melt. Aside from meteorites whose origin is somewhat unsettled, multi-species crystalline rocks in our experience apparently formed within the earth by magmatic processes or came from within the earth in molten form to crystallize on the surface.

In assessing the suitability of the word igneous to describe lunar rocks, we might compare the range of accepted ideas on the formation of the earth's "crust," both continental and oceanic, and the proposed ideas about the origin of the outer parts of the moon.

Baldwin (1970) suggests that available data show:

1. "Very early in its history, the moon became molten and chemically differentiated."
2. "The first. . . melting produced a relatively light-colored, low-density material which was exuded upward and formed a moonwide



1. Primitive anorthositic crust from first heat, 10-16 km.
 2. Minimum limit of solidification at circular maria impacts, 50 km.
 3. Minimum depth of lava for circular maria filling, 200 km.
 4. Maximum depth of lava for circular maria filling, 400 km.
 5. Possible undifferentiated zone, begins 538 to 738 km. deep.
- Primitive crust, 17 to 27 per cent of lunar volume.
Zone below lava melting limit, 69 to 45 per cent of volume.

FIGURE 2. Cross section of the moon with dimensions suggested by R. B. Baldwin. *Science*, December 18, 1970, pp. 1297-1300.

surface layer roughly 10-16 km thick."

3. "The outer layer of the moon quickly solidified and became thicker and more rigid as time went on."

4. "Impact cratering continued at a declining rate through the early stages."

5. "By the time the giant craters, such as Mare Imbrium. . .were formed the moon was solid and quite rigid to a depth of at least 50 km and probably to several hundred km." Thus, "The impacts. . .were made in solid rock. . . ."

6. "A substantial period of time elapsed before the vast lava flows of the maria occurred." (1 to 5×10^8 years)

7. "The lavas came roughly 10^9 years after the formation of the moon. . .not as one vast surge but in. . .localized floods."

8. "The lavas that formed the maria came from a considerable depth, probably close to 200 km but possibly deeper. This *second melting* presumably was caused by radioactive decay."

9. "In the deep regions, the present temperature is just below the melting point at the particular pressure involved. In other words, the moon is now hot and always has been hot."

10. "The lavas of the maria were formed by a small partial melting of deep-seated ultrabasic materials."

Thus it becomes necessary to invoke *two* periods of melting separated by a billion or so years to account for (a) a 4.5×10^9 year age for the moon, (b) a differentiated crust, (c) an apparently rigid and quiescent outer zone, and (d) a $3.5 \times 10^9 \pm$ age for Apollo 11 and 12 maria rocks.

Baldwin insists that lava flooding was not "triggered" by the huge impacts but occurred from deep melting at an appreciably later date. He admits that "we do not yet know that the uplands are composed largely of anorthosite" and "we do not yet have fully satisfactory solutions to the problem of the mascons," but he evidently expects Apollo 14 rocks to confirm the former and that the latter can eventually be accommodated to the theory of maria flooding by deep-seated basic rocks.

When we turn to the earth we find some gaps in our knowledge, also. We know the interior of the earth is hot because we have measured many temperature gradients and have seen lavas erupt but we still are not sure if it is heating or cooling or that we understand or even know all the sources of heat. It has been assumed, almost from observation of the first lava, that the earth was initially molten, although some have doubted (Urey, 1962). If the earth were melted and the outer portion cooled, it seems reasonable that a "primordial crust" must have been formed, but we have searched for that crust in vain (Knopf, 1955). Furthermore, although the earth is postulated to be approximately 4.5×10^9 years old, as are meteorites and the moon, we have been unable to find rocks older than about 3.3×10^9 years (Ahrens, 1955). This does not mean that there are none, but if no trace is left of a "primordial crust" we can't actually prove the earth was initially molten and cooled from that state.

But the earth does have a crust and definite ideas of its nature and origin have been suggested. Because of the contrasting parts of the

Lunar Rocks

earth's crust-continents and ocean floors - all theories are tied up with the question of the origin of the continents and have rather recently been profoundly altered by theories of continental drift.

In general, the evolution of the crust and the continents has included some of these ideas (Poldervaart, 1955; Wilson, 1967):

1. However the continents started, they have been added to by continual invasion by (largely acidic) intrusives. This has apparently occurred most often near continental outer edges.

2. Sediments in deep basins may have been infolded, remelted and reinjected into the crusts. Thus, some igneous rocks may not be primary "igneous" but partly second generation "igneous."

3. The ocean basin crust may have been, originally, mantle material that had also been invaded by differentiated material and thus is now lighter and less basic than the mantle.

4. Convection in the mantle, ascending under the ocean ridges, may descend near the continental margins carrying synclinal fillings deep enough for remelting (approximately 100 km, Wilson, 1967) or they may uplift and split continents by rising under them.

There are, indeed, theories of a "primordial crust" that was, but now is gone or unrecognizable. In a paper, read by title only at a previous meeting (Shotts, 1966), reference was made to "A primitive crust or 'sialic' scum. . .formed by differentiation of the upper mantle in the very early history of the earth when a completely molten earth began to cool. Subsequently, further differentiation and melting and gathering of foundered sialic crustal sections, resulted in evolution of the continental and ocean crusts of geologic times."

Poldervaart (1955) suggested not necessarily a "primordial crust" but ". . .more silicic magmas may be formed (early) in proportionally smaller amounts (than basaltic ones) by relatively low temperature partial melting of ultra mafic material in the presence of high concentrations of water. At the start of geologic history these conditions may have obtained, resulting in the formation of a thin crust of pumaceous silicic material." Later, ". . .running water rapidly eroded the original pumaceous crust. . ." and thus "thick cakes of silicic sediments formed in the original seas" and the continental crust gradually developed by accretion from differentiated and intruded, metamorphosed and premelted sediments.

In the same paper cited above, reference was made to a theory of external acquisition of a granitic crust "from the moon, from a hypothetical second satellite, or from asteroidal material near the end of the earth's growth by accretion" (Shotts, 1966), outlined in detail in an excellent article by Donn, et al. (1965).

In spite of the "primordial crust" theories, it seems that the earth's crust is not an original part of the earth but is a "built-up," secondary or growth feature and that what we term igneous rocks are rocks that have crystallized from magmas thrust into or through that crust and not rocks that crystallized directly from an originally molten earth. If the lunar highlands are a melt-derived crust that has not

been "worked," invaded, remelted and mixed, then these rocks may not properly be "igneous." A better case can be made for the maria fillings if these did, indeed, come from 22-400 km within the moon, but that too may have to wait for more evidence.

Thus, the chances are good that what we hoped to find on the moon when we planned exploration, namely very old rocks, some of them dating to the very dawn of creation, may prove true, at least in the lunar highlands. Since our familiar igneous rocks do not represent so ancient a period, nor do they appear to have originated in the same way, perhaps we should devise some new term such as 'archeoliths' or "eoliths" to apply to these rocks and perhaps to most, or all, meteorites.

LITERATURE CITED

- Ahrens, L. H. 1955. Oldest rocks exposed. Pages 155-168 *in* A. Poldervaart, ed. Crust of the earth. Geol. Soc. of America.
- Anon. 1971. Changing the lunar image. Time, 25 Jan.:42-43.
- Baldwin, R. B. 1971. Summary of arguments for a hot moon. Science 170(3964): 18 Dec.:1297-1300.
- Donn, W. L., B. D. Donn, and W. G. Valentine. 1965. On the early history of the earth. Bull. Geol. Soc. of America 76(3):287-306.
- Knopf, A. 1955. Bathyliths in time. Pages 685-702 *in* A. Poldervaart, ed. Crust of the earth. Geol. Soc. of America.
- Poldervaart, A. 1955. Chemistry of the earth's crust. Pages 119-144 *in* A. Poldervaart, ed. Crust of the earth. Geol. Soc. of America.
- Shotts, R. Q. 1966. The lunar crust. J. Ala. Acad. Sci. 37:338-344.
- Wilson, J. T. 1967. Theories of building of continents. Pages 445-473 *in* R. F. Gaskell, ed. The earth's mantle. Academic Press, New York.
- Urey, H. C. 1962. Evidence regarding the origin of the earth. Geochem. et Cosmochem. Acta 26:1-14.

Vacuum X-ray Reflectometer

A VACUUM X-RAY REFLECTOMETER

John M. Reynolds
Space Sciences Laboratory
George C. Marshall Space Flight Center, Alabama

X-RAY REFLECTOMETER

The vacuum X-ray reflectometer is a unique instrument designed to allow precision measurements of X-ray reflection with an angular resolution of a few seconds of arc. The instrument is mounted on a base-plate 63 cm by 163 cm. It can be removed from the vacuum chamber for initial alignment and for cleaning the chamber. After the system is inserted into the chamber, all motions necessary for its operation are accomplished by magnetic rotary feedthroughs. These motions include the adjustment of the slits, the precision-divided circles, and the large and small detector arms. The primary components of the system are (1) a monochromating crystal, (2) an optical flat or sample, (3) detectors, (4) an X-ray source, and (5) a remote readout system. The system can be operated in two modes: (1) with the appropriate X-ray filters, and (2) with an analyzing crystal, as shown in Figure 1.

The X-ray source is a microfocus, windowless, oil-cooled X-ray tube. The dimensions of the emitting region of the source are about 0.2 mm by 4 mm, with the 4-mm dimension extended perpendicularly to the plane of the diagram (Fig. 1; Fig. 2, item 1; and Fig. 3). The X-ray source has changeable targets so that various X-ray wavelengths can be generated.

Both the crystal and the sample are mounted on precision-divided circles manufactured by Hilger and Watts, Ltd., London, and known as Precision Microptic Clinometer Model TB80.¹ These have the following features: (1) direct reading to 0.2 sec of arc and (2) a two-sided, circle-reading system (Figs. 2 and 4, items 2 and 3). The instrument is designed for very precise angular setting and can be used in either a horizontal or vertical plane. The units consist of a base, a totally enclosed circular glass scale, and a spirit level. The scale is divided from 0 to 360 degrees at intervals of 5 min of arc. Subdivision of the graduations on the circle is made by an optical micrometer whose scale is divided at intervals of 0.2 sec of arc. Both turntables are carefully aligned before insertion into the vacuum chamber by use of an automatic collimator (Fig. 2, item 4). The remote angular adjustment on the crystal turntable is used to fine-tune the crystal to obtain the maximum X-ray flux after the vacuum chamber is at the appropriate pressure. The sample turntable can be remotely operated through its full 360-degree range and its position can be remotely read by a fiber optics light pipe. The sample holder is designed to hold samples 0.635 cm thick by 2.54 cm

¹Use of trade names or names of manufacturers in this paper does not constitute an official endorsement of such products or manufacturers, either expressed or implied, by the National Aeronautics and Space Administration or any other agency of the United States Government.

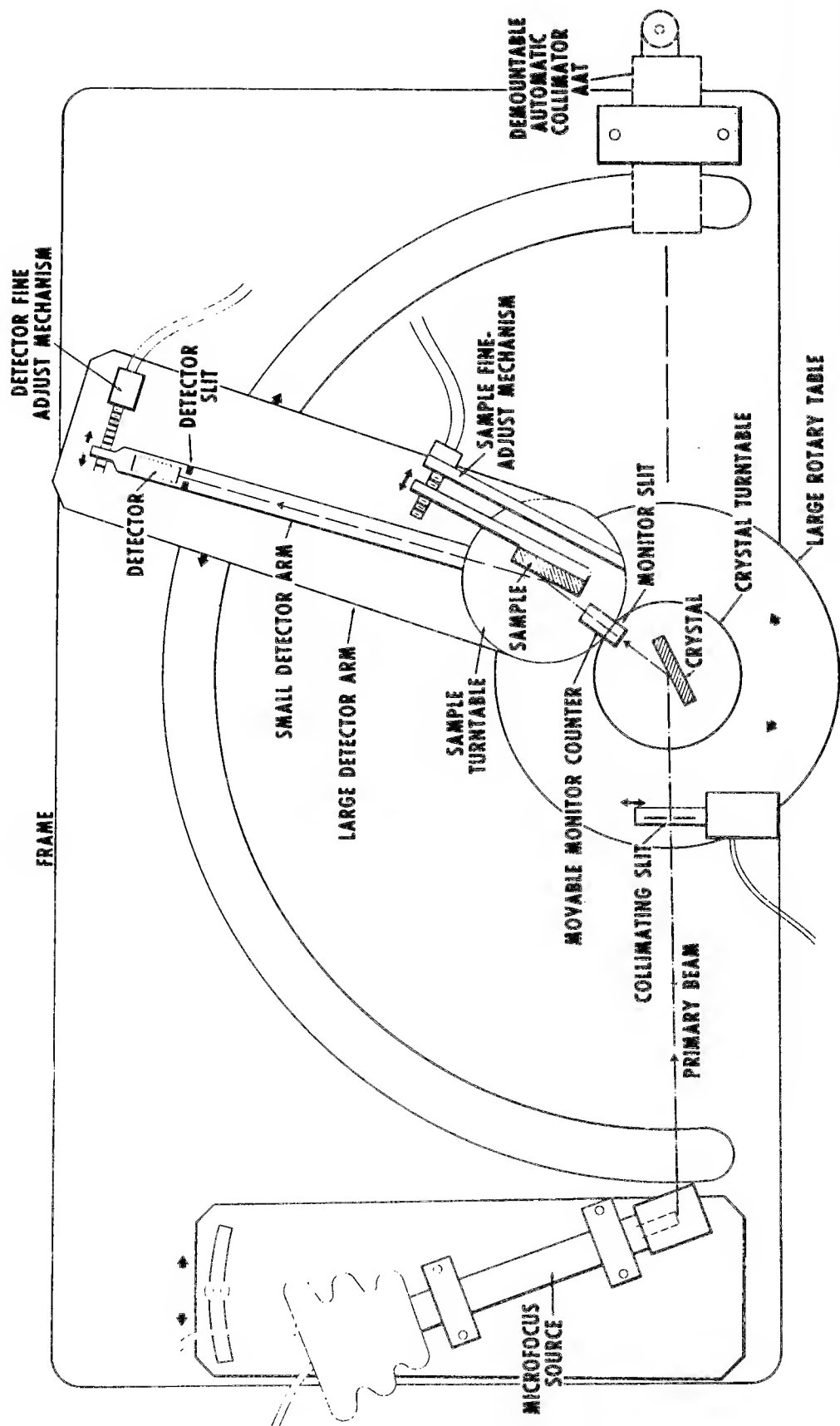


FIGURE 1 VACUUM X-RAY REFLECTOMETER GENERAL DESIGN

Vacuum X-ray Reflectometer

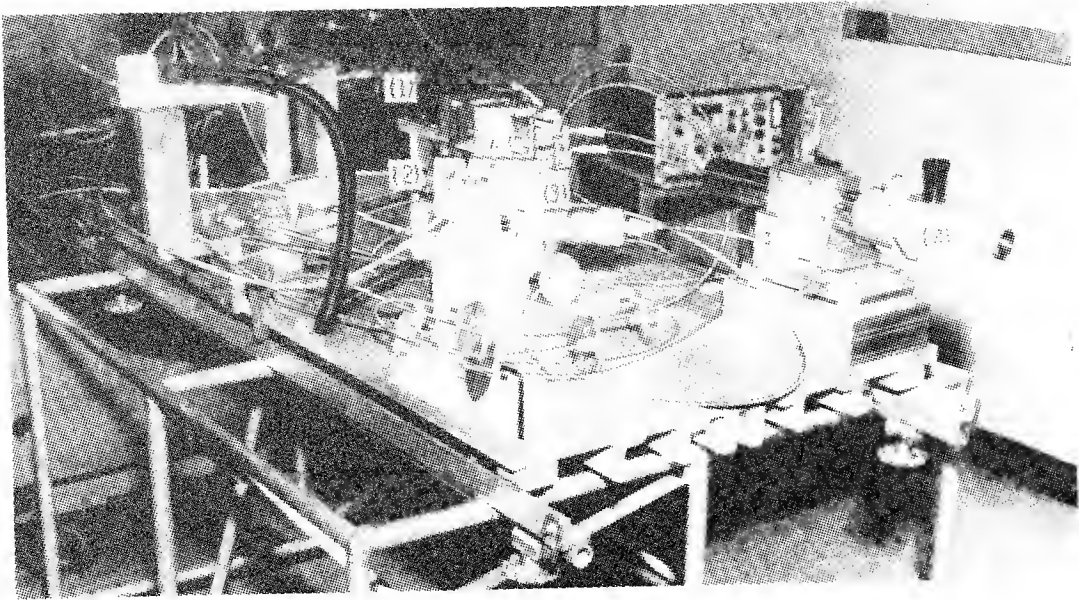


FIGURE 2. Vacuum X-ray reflectometer.

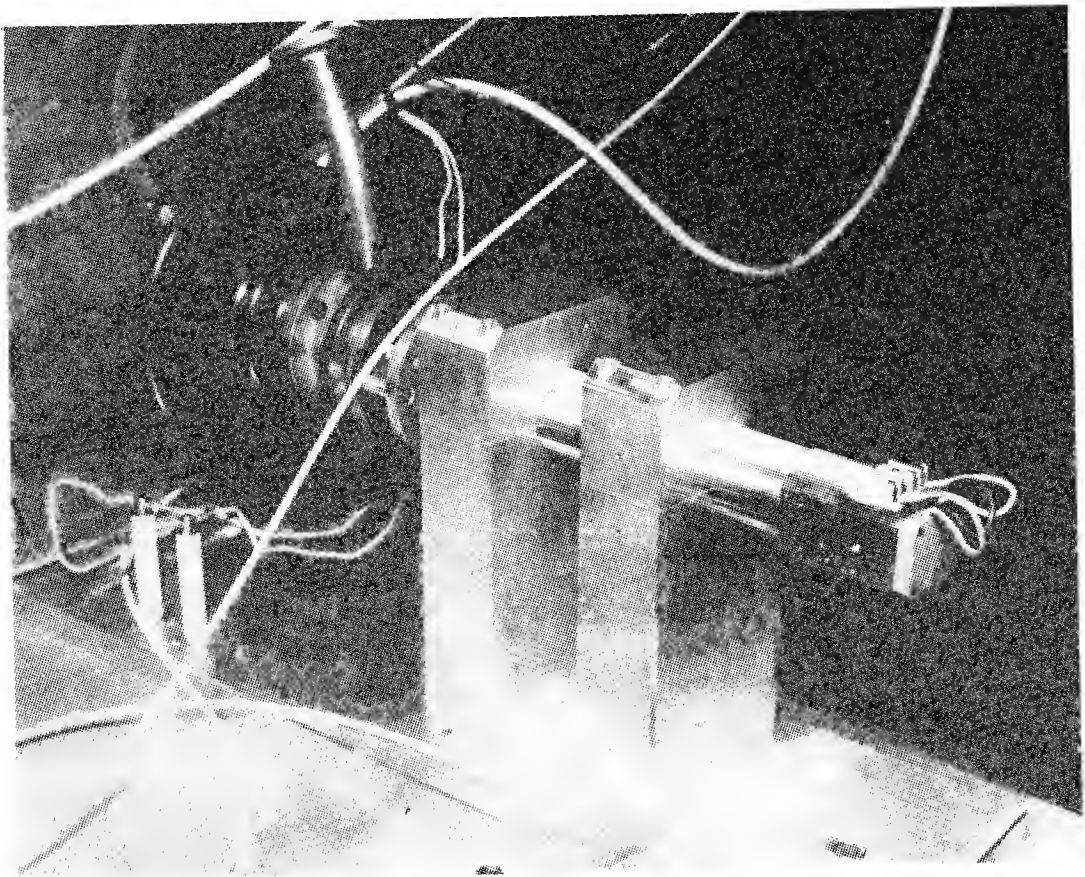


FIGURE 3. Microfocus X-ray tube.

diameter.

The vacuum X-ray reflectometer uses two detectors during operation. One detector is mounted between the crystal and the sample (Fig. 4, item 5). The purpose of this detector is to monitor the radiation that is striking the sample surface, and the constancy of the X-ray flux measurements of the incident flux are required when the instrument operating current or voltage is changed, each time the instrument is turned on, and at reasonable intervals during continuous operation. The frequency of measurements during continuous operation will depend on such variables as vacuum pressure, system cleanliness, and operating voltage and current. The second detector is mounted on two arms, both pivoted at the axis of the sample turntable (Fig. 5, item 6). The purpose of the larger arm (the one resting on the baseplate) is to provide rough positioning of the detector during initial alignment and also in remote operation. The smaller arm, the one to which the detector and detector slit are attached, provides for fine positioning and scanning of the detector through the X-ray beam reflected from the sample, thus giving the angular profile of the beam. The fine position arm is movable through a 10-degree arc.

The detectors used to measure the X-ray flux are of two types — Geiger tube and Channeltron. The Geiger-tube detectors are filled to

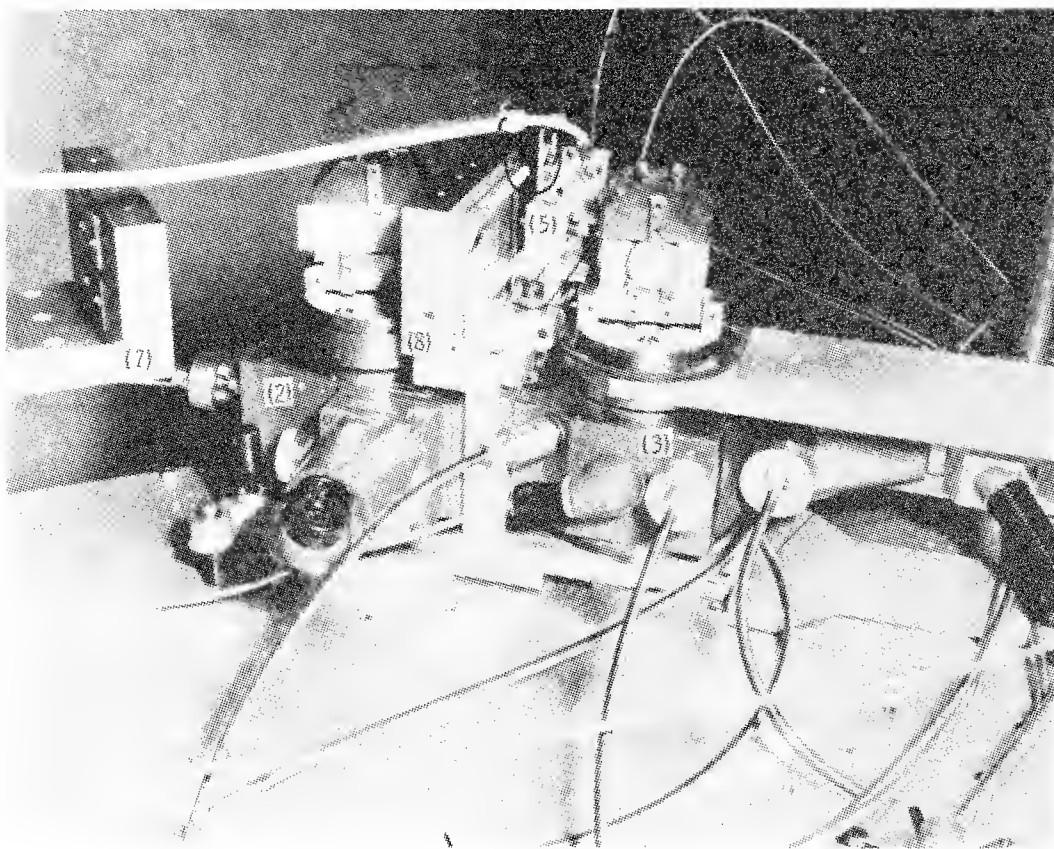


FIGURE 4. Precision-divided circles with crystal and sample device.

Vacuum X-ray Reflectometer

91 417.14 N/m² with argon and halogen and have a 1.5-mg/cm² mica window. The Channeltron detector (model no. CEM 4039-C) is a hollow glass tube whose inside surface is coated with a semiconducting material. This material serves as the secondary electron-emitting dynode surface and also as the voltage divider, which establishes the electrostatic field required for acceleration of the secondary electrons. A summary of the principle of operation is as follows: If a single particle or proton enters the CEM input aperture and causes the emissions of electrons from the dynode, a charge pulse containing millions of electrons will emerge from the output aperture.

The X-ray reflectometer has three slits — the collimating slit, the monitor slit, and the detector slit. The openings of the slit to the proper width are measured by micrometers. The collimating slit is located between the microfocus source and the crystal (Fig. 4, item 7) and its jaws are independently adjustable for defining the X-ray beam. The purpose of the slit is to limit the divergence of the beam to a few arc seconds. If the slit were not used, the entire crystal would be illuminated and the Bragg condition would then be satisfied for different wavelengths at different points on the crystal. Thus, the reflected beam would be nonmonochromatic as well as nonparallel. The monitor slit is located between the crystal and the movable monitor counter and its

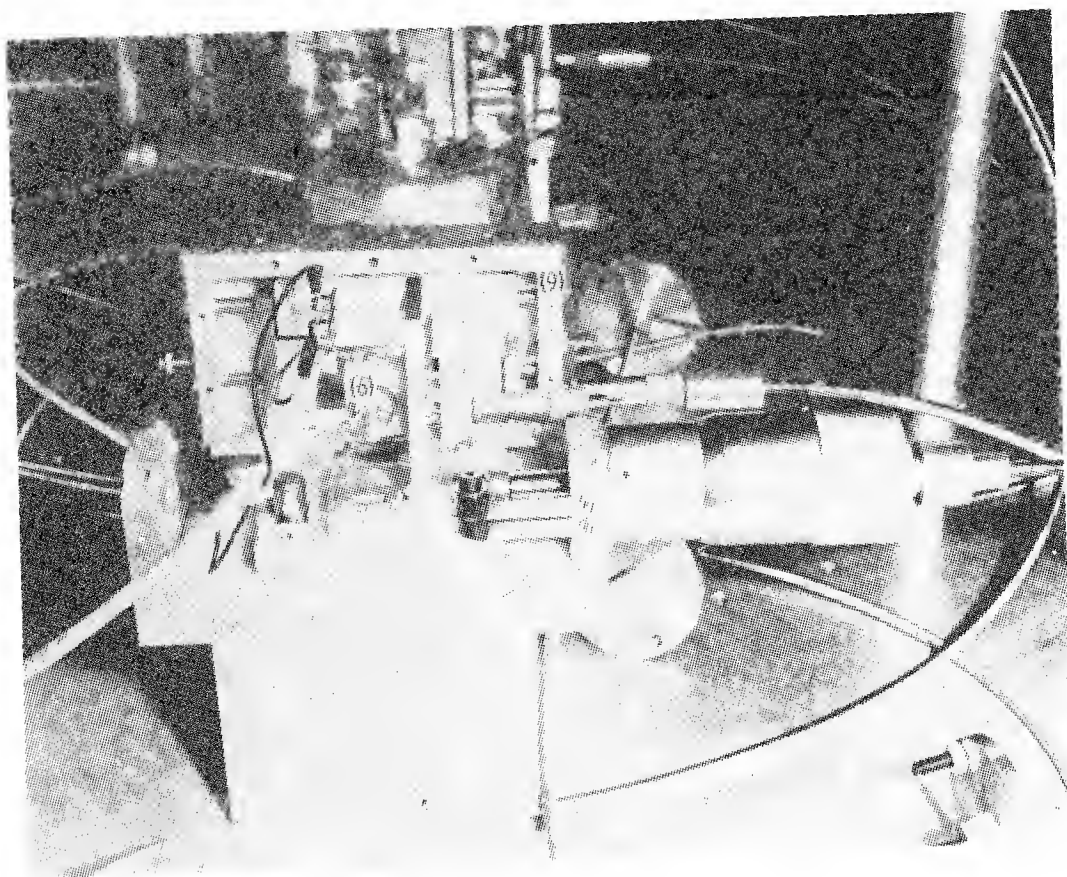


FIGURE 5. Detector and detector slit assembly.

jaws also are independently adjustable. The purpose of the monitor slit is to confine the X rays to the face of the sample being measured. The detector slit has two adjustments, one for the size of the slit jaw opening and the other for a translation adjustment (Fig. 5, item 9).

A series of curves obtained using the collimating slit and the detector slit shows the profile of the X-ray beam for a particular collimating slit width. Both the crystal and the sample were removed, and the monitor slit was opened to its maximum width. The collimating slit openings and the maximum profile width are as follows.

<u>Slit Openings</u>	<u>Profile Width</u>	
0.1016 mm	1.043 mm	(Fig. 6)
0.0762 mm	0.9652 mm	(Fig. 7)
0.0508 mm	0.8128 mm	(Fig. 8)
0.0431 mm	0.7874 mm	(Fig. 9)
0.0254 mm	0.7874 mm	(Fig. 10)

ENVIRONMENTAL VACUUM CHAMBER

The environmental vacuum chamber (Fig. 11) is completely oil-free and bakeable at 250°C. The chamber is 122 cm in diameter and 183 cm long and contains a liquid nitrogen shroud 106 cm in diameter and 152 cm long. Located in the rear of the chamber is a small liquid nitrogen shroud 70 cm in diameter and 30 cm long. The system is rough-pumped with four banks of sorption pumps mounted on a manifold that is connected to the chamber through a bakeable valve. The primary pump is a 3.000-m³/sec ion pump and a secondary 0.800-m³/sec ion pump. An additional pumping speed of 5.000 m³/sec is obtained by a titanium sublimator located in the small shroud. A typical pump-down curve for an empty chamber and one with the vacuum X-ray reflectometer are shown in Figure 12.

Vacuum X-ray Reflectometer

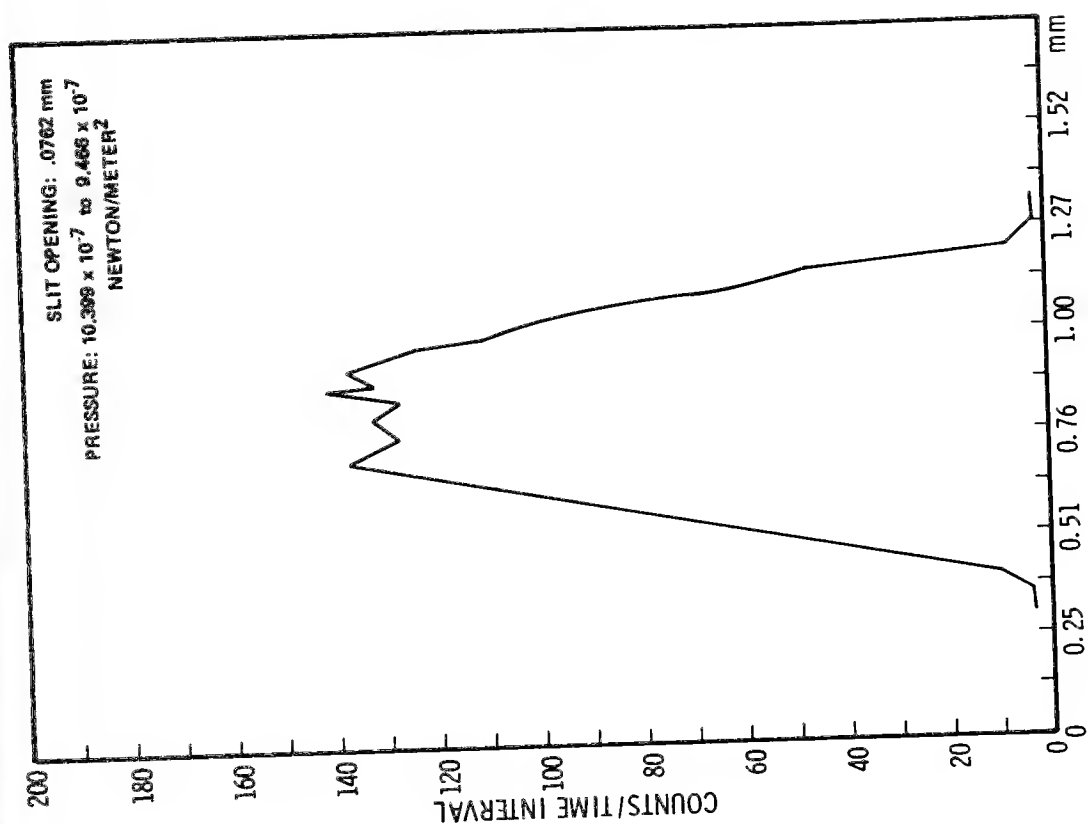


FIGURE 7. X-ray flux for 0.0762 mm.

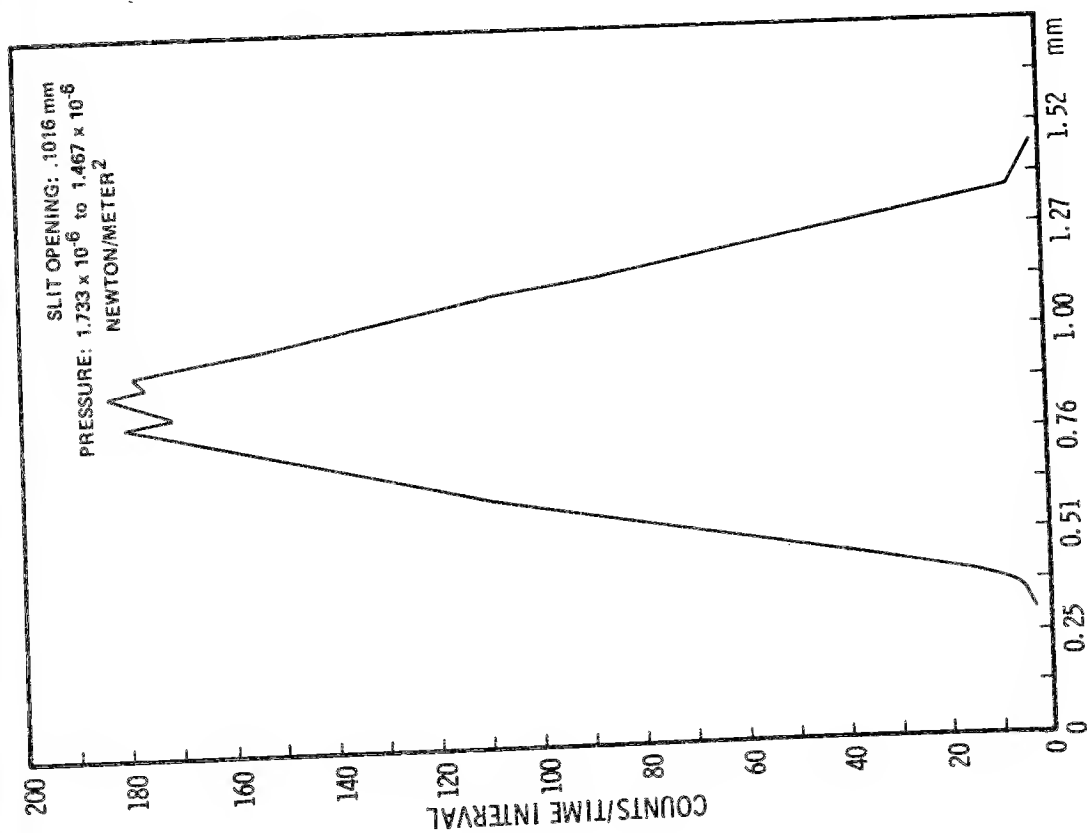


FIGURE 6. X-ray flux for 0.1016 mm.

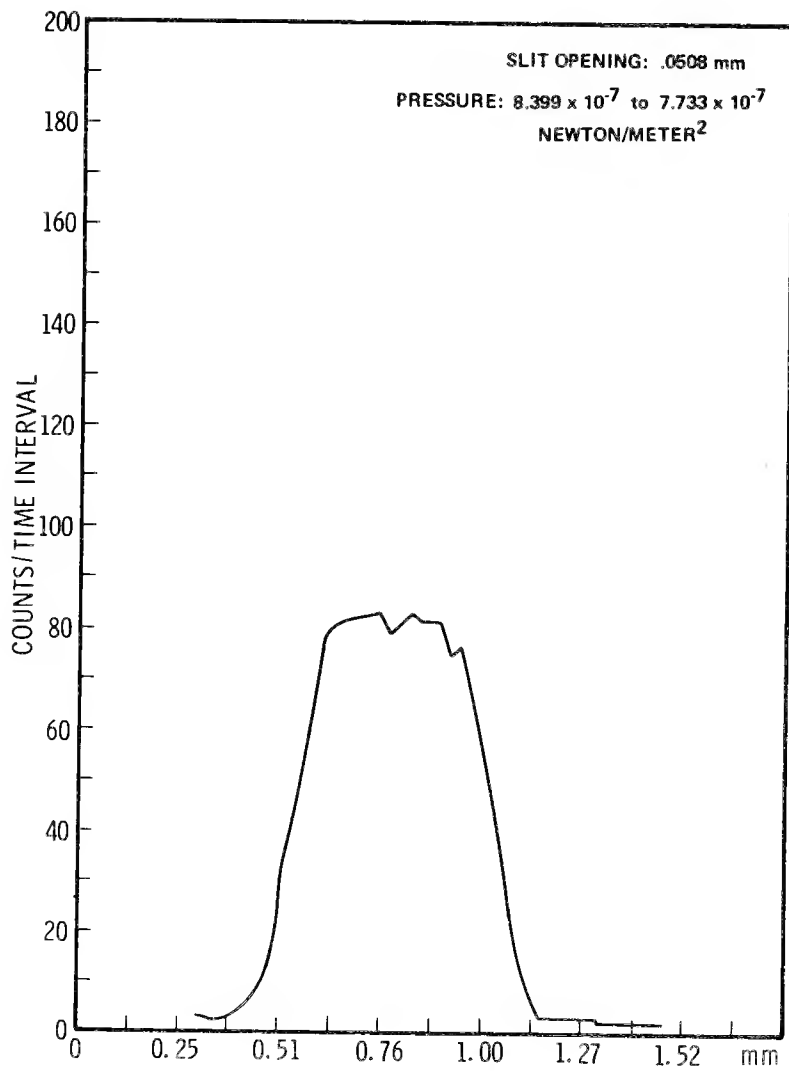


FIGURE 8. X-ray flux for 0.0508 mm.

Vacuum X-ray Reflectometer

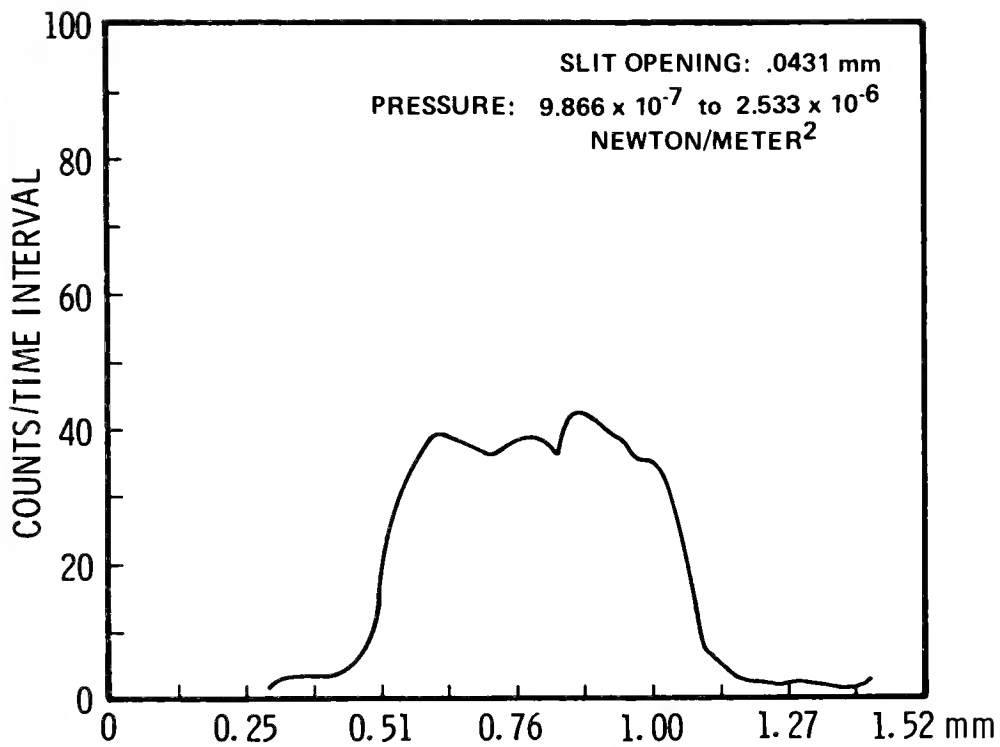


FIGURE 9. X-ray flux for 0.0431 mm.

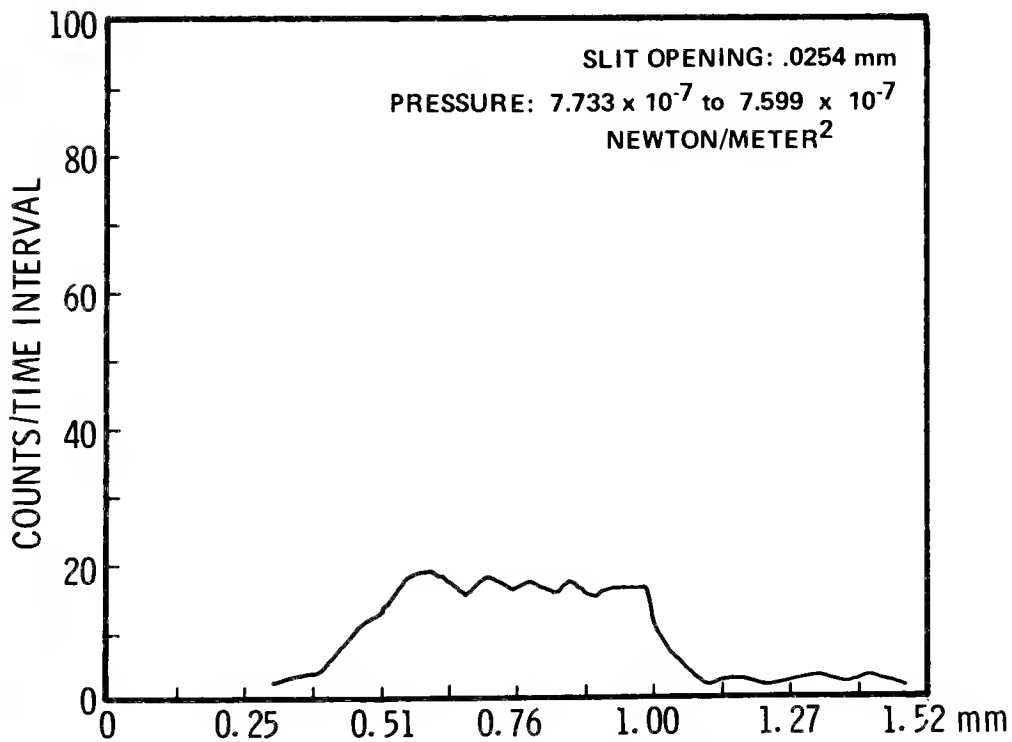


FIGURE 10. X-ray flux for 0.0254 mm.

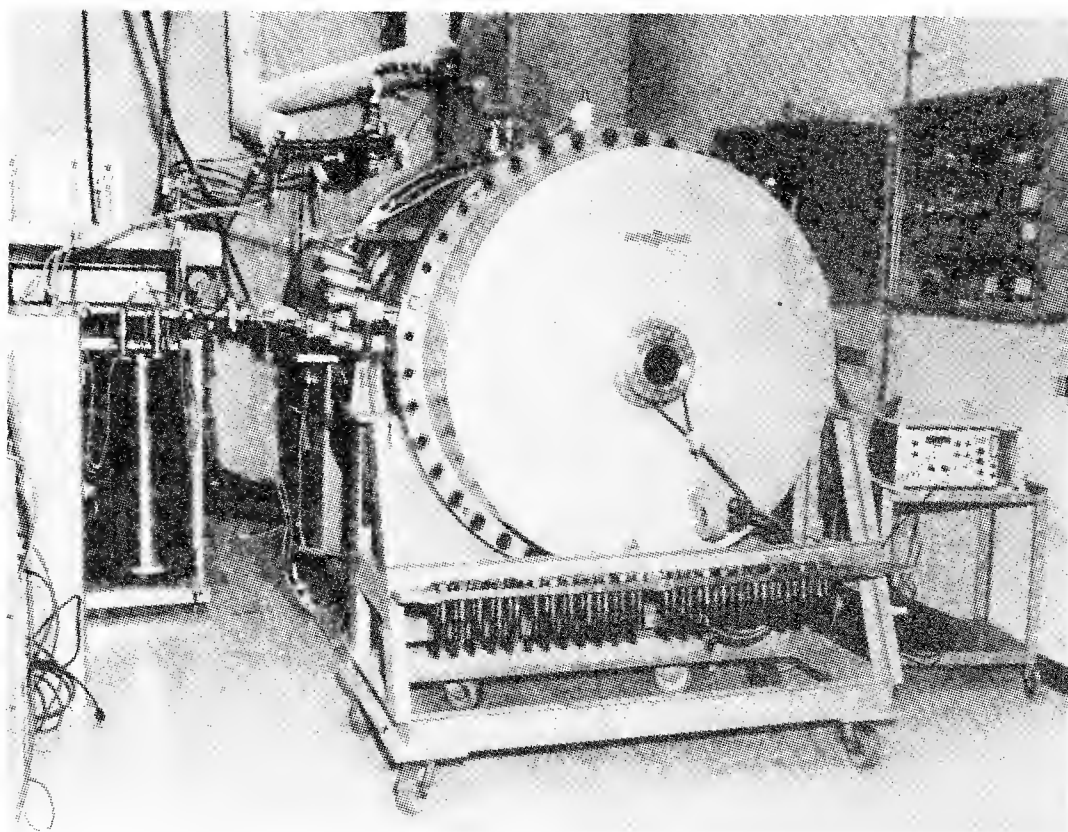


FIGURE 11. Environmental vacuum chamber.

Vacuum X-ray Reflectometer

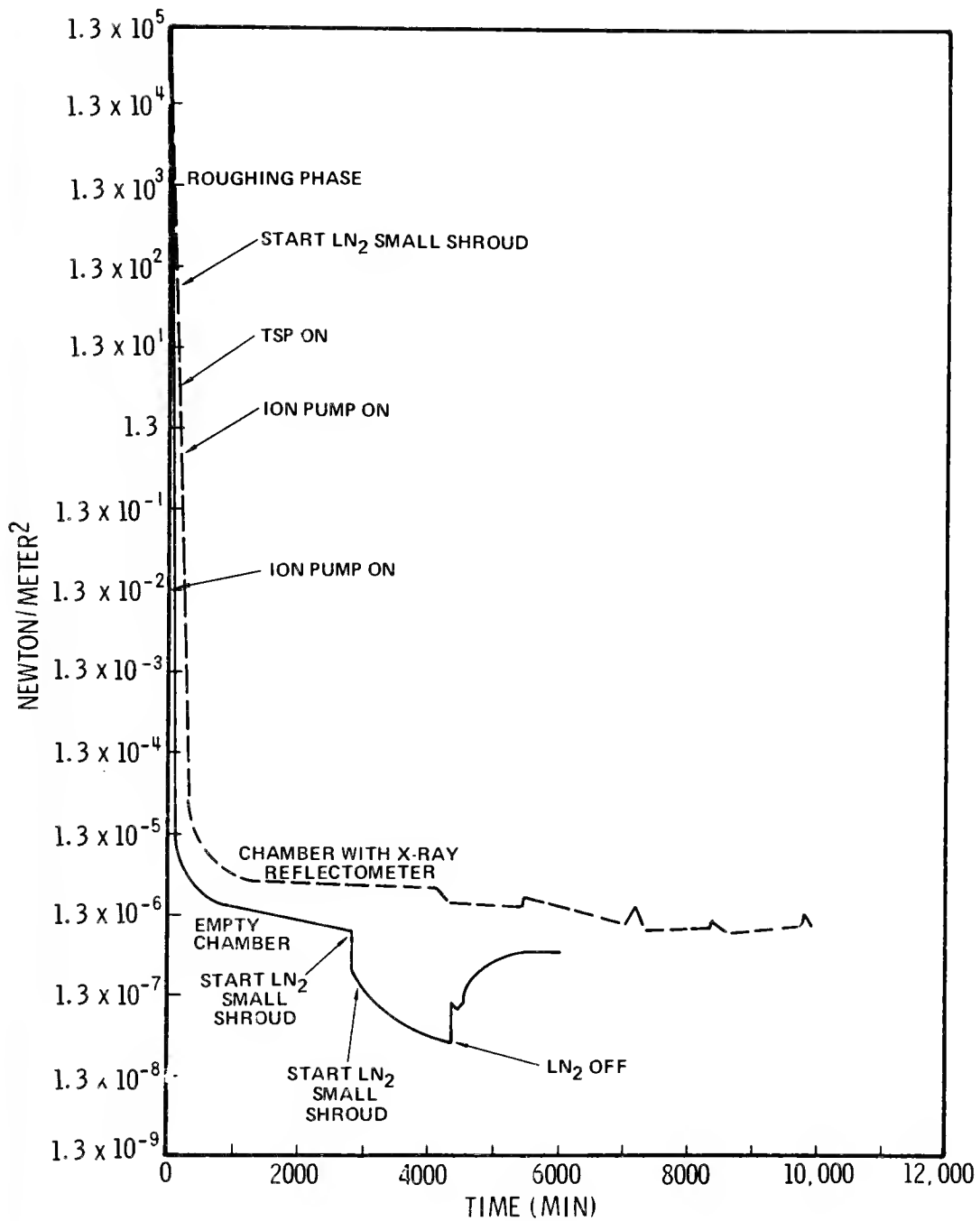


FIGURE 12. Vacuum system pump-down curve.

REFLECTION EFFICIENCY OF VARIOUS MATERIALS IN THE X-RAY REGIONS
OF 0.8 TO 2.5 nm AND 4.4 TO 8.0 nm

Stanley A. Fields
Space Sciences Laboratory
George C. Marshall Space Flight Center, Alabama

INTRODUCTION

The experimental results given in this paper represent those obtained by the author in his laboratory facilities and those which have been reported in the literature. An attempt was made to review all the papers containing information concerning the experimental reflection efficiency of optical flats in the 0.8- to 2.5-nm and 4.4- to 8.0-nm wavelength regions of the spectrum. Papers which were not published in English (the translations were not available) have been omitted. Reflection efficiency curves are plotted for all materials which were reported in the literature reviewed. In some cases, not all wavelengths of radiation were plotted because it would overcrowd the figure. However, the shortest and longest wavelengths within the two ranges are plotted in each case. Also, only one curve for each wavelength is plotted regardless of the number of experimenters who studied a material at the same wavelength. The experimental results are compared and summarized over the wavelength regions specified.

X-RAY REFLECTION

The index of refraction of any material for X rays is slightly less than unity. Simply classical dispersion theory shows that the index of refraction

$$\mu = 1 - \delta, \quad (1)$$

where $\delta = ne^2\lambda^2/2\pi mc^2$, in which n is the total number of electrons per unit volume; and e , m , c , and λ are the electronic charge, the mass of the electron, the velocity of light, and the wavelength, respectively. If the complementary angle of those in normal optics is used in Snell's law, as shown in Figure 1, then

$$\mu = \cos i / \cos r, \quad (2)$$

where i is the grazing angle of incidence measured in the less dense medium and r is the grazing angle of refraction. For an angle i_c and all smaller angles, X rays incident on the more dense medium will be totally reflected in the less dense medium. In the limit $r = 0$,

$$\cos r = 1$$

and

$$\mu = \cos i_c. \quad (3)$$

Reflection Efficiency

Combining Eqs. (1) and (3) gives

$$\cos i_c = 1 - \delta. \quad (4)$$

To a sufficient degree of approximation,

$$\cos i_c = 1 - i_c^2/2, \quad (5)$$

then

$$i_c = \sqrt{2\delta}. \quad (6)$$

Thus, if the X rays strike the surface at a grazing angle less than i_c , total reflection will take place.

EXPERIMENTAL APPARATUS

The general experimental apparatus for studies of X-ray reflection consist of an X-ray source, slits to confine the radiation to the reflecting surface, a sample holder, and a detector system. The sample holder must be adjustable so that the angle between the sample surface and the incident radiation θ may be varied. Figure 2 is a schematic of the experimental apparatus used by the author to study the reflection of X rays. A detailed description of the instrument is given in another paper by J. M. Reynolds [1].

EXPERIMENTAL RESULTS

The results of the author's experimental work and the results reported in the literature are summarized. Table 1 gives the materials which have been studied and the wavelengths which have been used in making the studies.

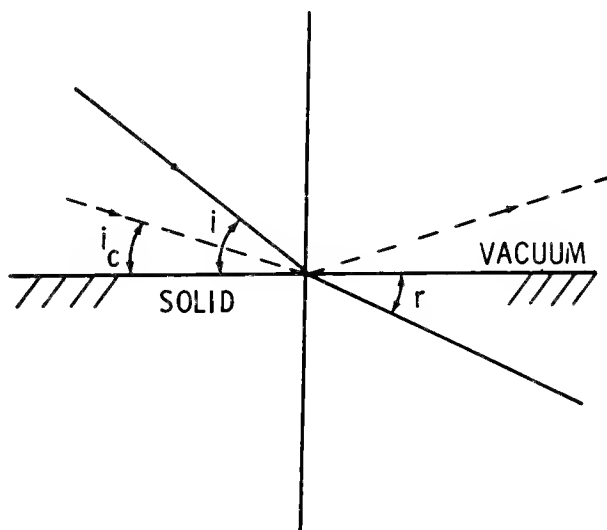


FIGURE 1. Critical angle for total reflection of X rays.

The reflection efficiency of the following materials was reported in the literature reviewed.

Glass

Hendrick [2] using aluminum K radiation studied the reflection efficiency of 3 x 4-cm glass optical flats. The flats were medium quality, Army-surplus optical windows from which the antireflecting coatings were dissolved. A 15- μ aluminum-foil filter was used to give the 0.832 nm radiation. The reflection efficiency curve is given in Figure 3. Stewardson and Underwood [3] made X-ray reflection efficiency measurements at wavelengths including 0.834, 0.989, 1.131, 1.228, 1.330, 1.46, and 1.60 nm on glass samples which were flat to within one-tenth wavelength of visible (green) light. The curve for the 1.60 nm radiation is shown in Figure 3. The reflection efficiency of F-1 glass was determined by Ershov et al. [4] at wavelengths including 0.834, 0.989, 1.225, 1.334, 1.456, 1.597, 1.779, 1.945, 2.164, 2.478, and 4.44 nm. A diffraction grating of 600 lines/mm was used to monochromate the X-ray beam. The reflection curve for 2.478-nm radiation is given in Figure 3. The reflection curve for optically polished glass was determined by Johnson and Wuerker [5] at 4.46 nm and is given in Figure 3. Wuerker [6] also reported the reflection efficiency curve for glass at 4.46 nm. Figure 3 also gives the reflection efficiency curve for F-1 glass at 6.7 nm as determined by Lukirskii and Savinov [7]. They also made measurements at 2.36 and 4.4 nm.

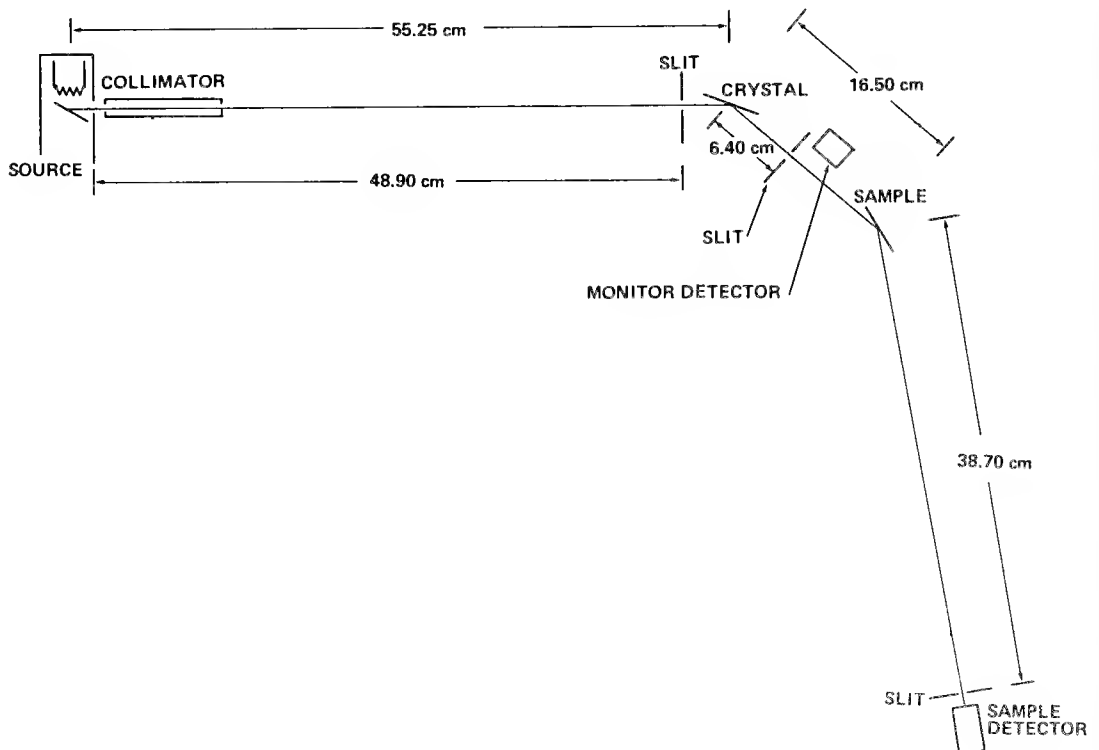


FIGURE 2. Schematic of the experimental apparatus used to study the reflection of X rays.

Reflection Efficiency

Wavelength (nm)	0.831	0.832	0.834	0.989	1.044	1.131	1.225	1.228	1.33	1.334	1.456	1.46	1.597	1.60	1.759	1.945	2.164	2.36	2.362	2.472	2.478	4.40	4.44	4.46	6.7
Material																									
Glass		X	X	X		X	X	X		X	X		X		X	X	X	X	X			X	X	X	X
Quartz																									
Beryllium	X																	X				X	X	X	X
Carbon																		X				X	X	X	X
Magnesium	X																								
Aluminum	X			X	X		X			X	X		X		X	X	X	X	X	X		X	X	X	X
Titanium							X			X	X		X		X	X	X	X	X			X	X	X	X
Vanadium				X						X	X		X		X	X	X	X	X						
Chromium	X		X	X			X			X	X		X			X	X	X	X	X		X			X
Stainless Steel			X	X				X	X			X		X											
Nickel			X	X	X		X			X			X		X	X	X	X	X	X			X		
Copper	X																								
Germanium			X				X			X	X		X		X	X	X	X	X	X		X	X	X	X
Silver	X																					X	X	X	X
Gold	X	X			X		X			X	X		X		X	X	X	X	X	X	X	X	X	X	X
Polystyrene																		X				X			X
KCl																		X				X			X
SrF ₂																		X				X			X
MgF ₂																		X				X			X
LiF																		X				X			X

TABLE 1. Materials tested versus wavelength.

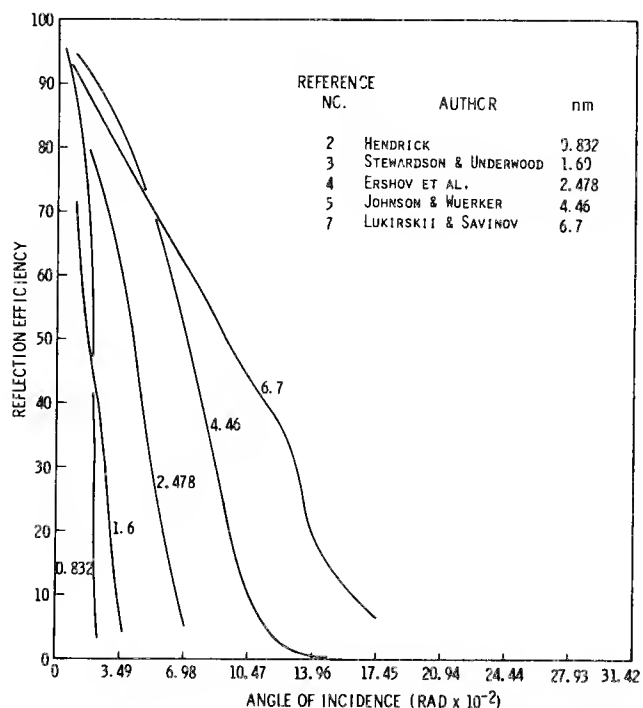


FIGURE 3. Reflection curves for glass.

Quartz

Reflection efficiency measurements of quartz flats have been made for 4.46-nm radiation by Johnson and Wuerker [5], Wuerker [6], and Dershem and Schein [8]. The reflection efficiency curve determined by Johnson and Wuerker [5] is given in Figure 4.

Beryllium

The initial reflection efficiency curve generated on the X-ray reflectometer (Fig. 2) was for a sample prepared by vacuum depositing approximately 100 nm of beryllium onto a fused silica substrate. The substrate was finished to $\lambda/10$. The reflection efficiency curve for 0.831 nm radiation is given in Figure 5. Lukirskii et al. [9] determined the reflection efficiency of beryllium at several wavelengths including 2.36 nm, 4.4 nm, and 6.7 nm. The curves for the 2.36- and 6.7-nm tests are given in Figure 5. Wuerker [6] determined the reflection efficiency of beryllium at 4.46 nm radiation (Fig. 5).

Carbon

A carbon layer was deposited on a glass flat by deposition from a vacuum arc by Lukirskii et al. [9]. Reflection efficiency measurements were made at several wavelengths including 2.36, 4.4, and 6.7 nm. The efficiency curves for 2.36 and 6.7 nm are given in Figure 6. Wuerker [6] determined the reflection efficiency of carbon at 4.46 nm (Fig. 6).

Magnesium

Using 0.83 nm radiation, Hendrick [2] determined the reflection

Reflection Efficiency

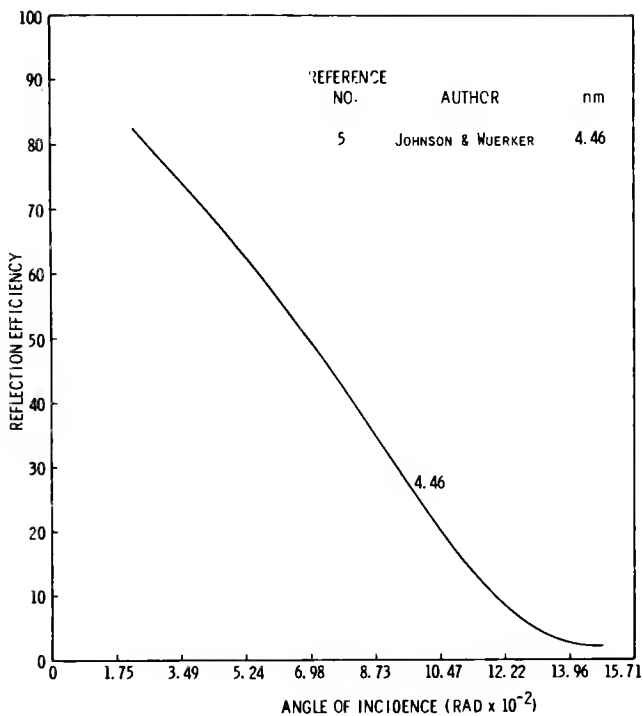


FIGURE 4. Reflection curve for quartz.

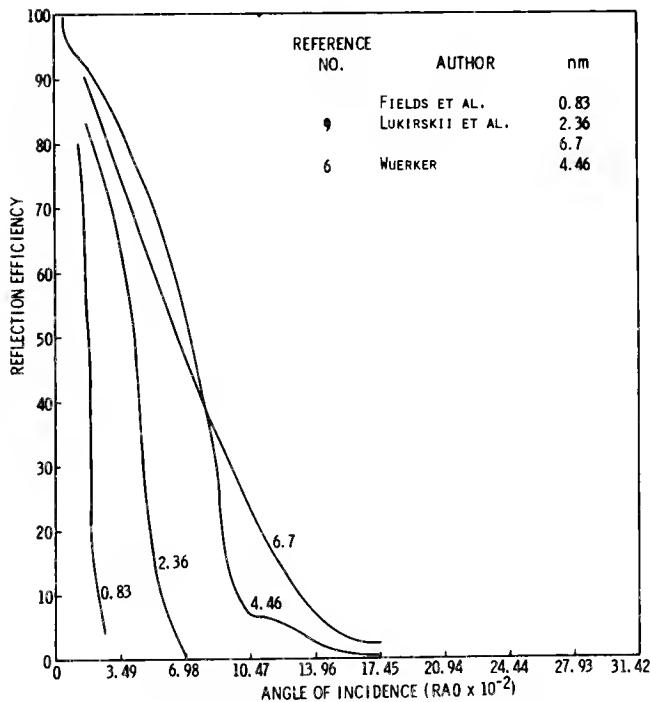


FIGURE 5. Reflection curves for beryllium.

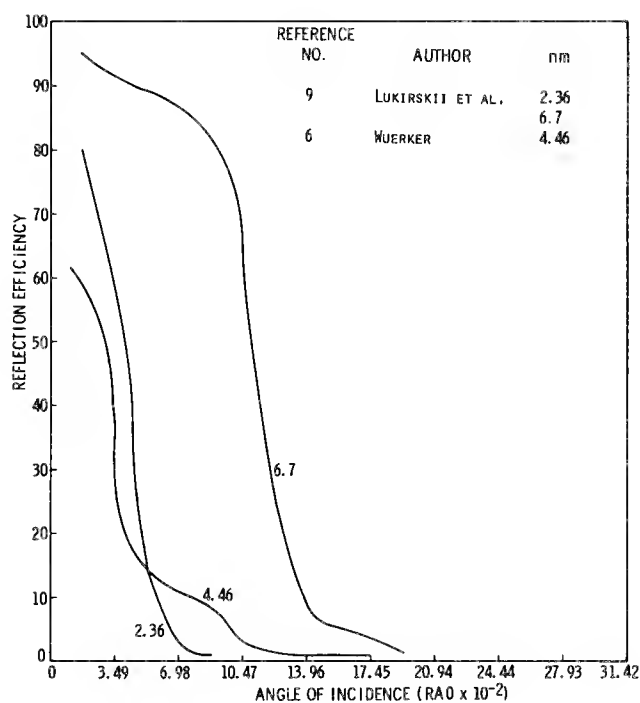


FIGURE 6. Reflection curves for carbon.

efficiency curve for magnesium (Fig. 7).

Aluminum

Hendrick [2] reported reflection efficiency measurements with 0.832 nm radiation of aluminum deposited on glass flats. He made measurements of 250-, 71.6-, and 30-nm thick aluminum films. The reflection efficiency curve for the 250-nm film is shown in Figure 8. Ershov et al. [4] made reflection efficiency measurements at wavelengths including 0.834, 0.989, 1.225, 1.334, 1.456, 1.597, 1.779, 1.945, 2.164, 2.478, and 4.44 nm. A diffraction grating of 600 lines/mm was used to monochromate the X-ray beam. The reflection efficiency curve for 1.597 and 2.478 nm is given in Figure 8. The reflection efficiency for an aluminum film vacuum deposited on a quartz substance by Johnson and Wuerker [5] is given in Figure 8 for 4.46-nm radiation. Wuerker [6] also published a reflection efficiency curve for aluminum at 4.46-nm radiation. Lukirski et al. [9] determined the reflection coefficients for aluminum at wavelengths including 2.36, 4.4, and 6.7 nm. The reflection efficiency curve for 6.7 nm is shown in Figure 8.

Titanium

The reflection of titanium has been determined by Ershow et al. [4] at wavelengths including 1.225, 1.334, 1.597, 1.759, 1.456, 1.945, 2.164, 2.478, and 4.4 nm. The curves for 1.225, 2.478, and 4.4 nm are given in Figure 9. Lukirskii and Savinov [7] reported results on the reflection

Reflection Efficiency

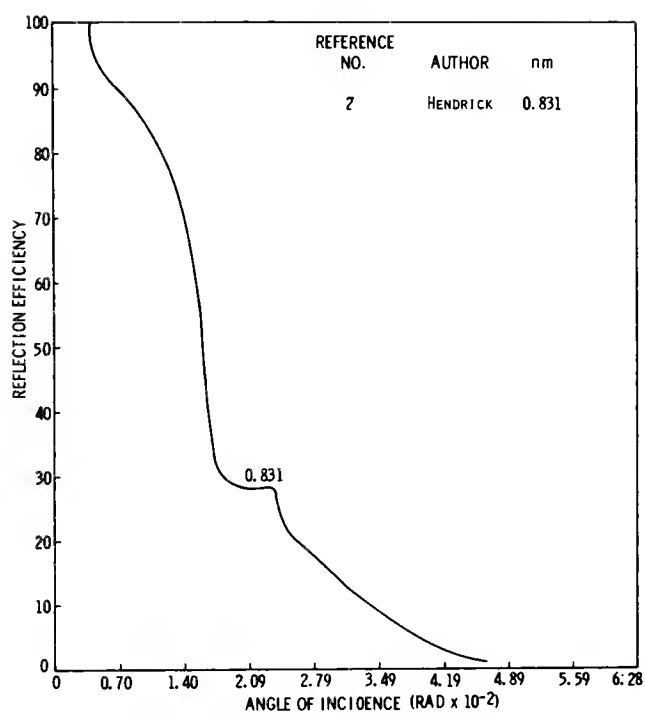


FIGURE 7. Reflection curve for magnesium.

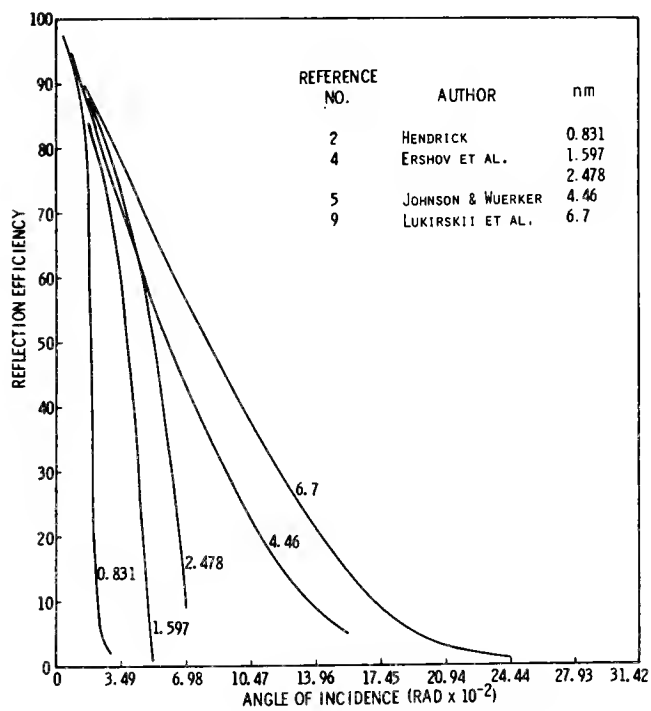


FIGURE 8. Reflection curves for aluminum.

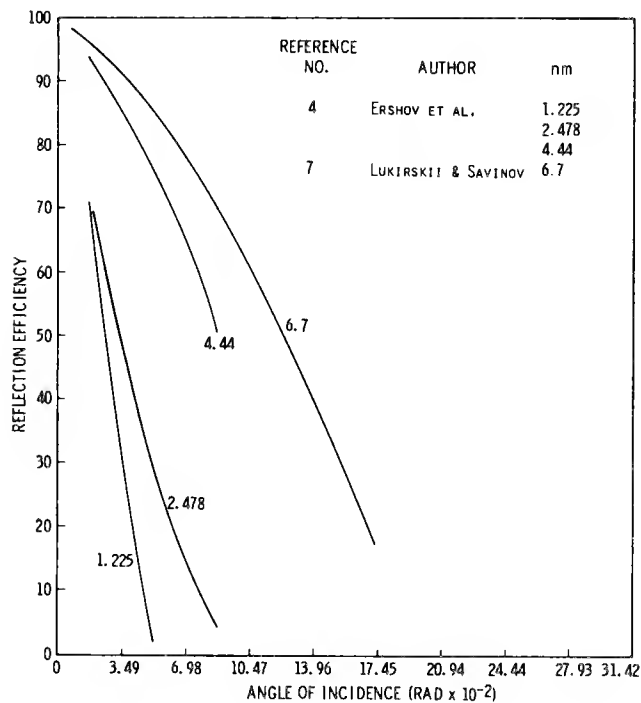


FIGURE 9. Reflection curves for titanium.

efficiency of titanium at wavelengths including 2.36, 4.4, and 6.7 nm. The 6.7-nm curve is given in Figure 9. Data at these same wavelengths have also been reported by Lukirskii et al. [9].

Vanadium

Ershov et al. [4] are the only ones to report any studies of vanadium. They made measurements which included wavelengths of 0.989, 1.334, 1.456, 1.597, 1.759, 1.945, 2.164, 2.478, and 4.44 nm. The reflection efficiency curves for 0.989, 2.478, and 4.44 nm are given in Figure 10.

Chromium

Reflection efficiency measurements of chromium have been made by Ershov et al. [4] at wavelengths including 0.831, 0.989, 1.225, 1.334, 1.456, 1.597, 1.945, 2.164, 2.362, 2.478, and 4.44 nm. The reflection curves for 0.831 and 2.478 nm are given in Figure 11. Lukirskii et al. [9] reported measurements at wavelengths which include 2.364, 4.4, and 6.7 nm; the curves for 4.4 and 6.7 nm are shown in Figure 11.

Stainless Steel

Stewardson and Underwood [3] using stainless steel optical flats made reflection efficiency measurements at wavelengths including 0.834, 0.989, 1.228, 1.336, 1.460, and 1.6 nm. The stainless steel samples were flat to one-tenth wavelength of visible (green) light. The reflection efficiency curves for wavelengths of 0.834, 1.228, and 1.600 nm are shown in Figure 12.

Reflection Efficiency

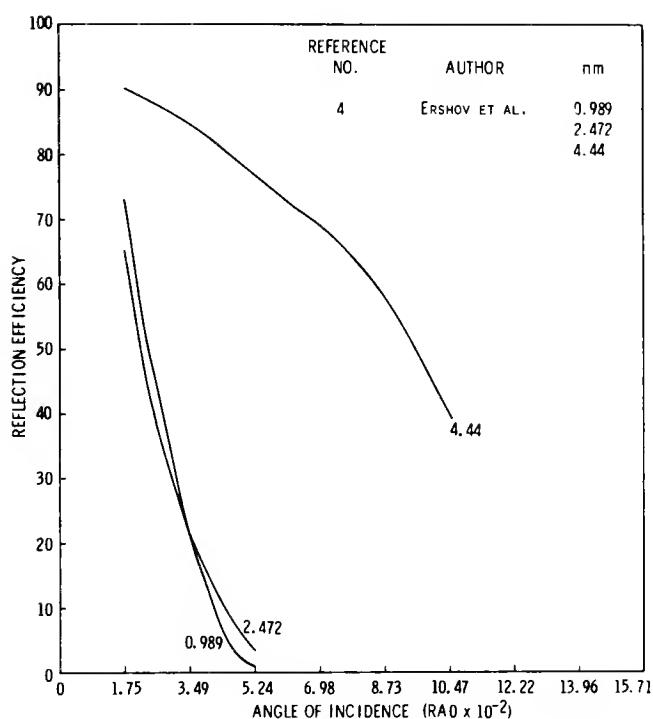


FIGURE 10. Reflection curves for vanadium.

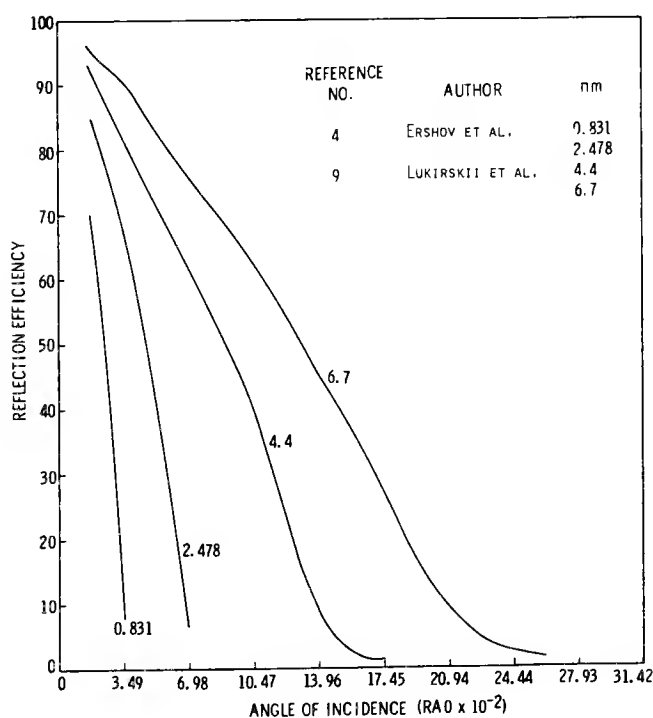


FIGURE 11. Reflection curves for chromium.

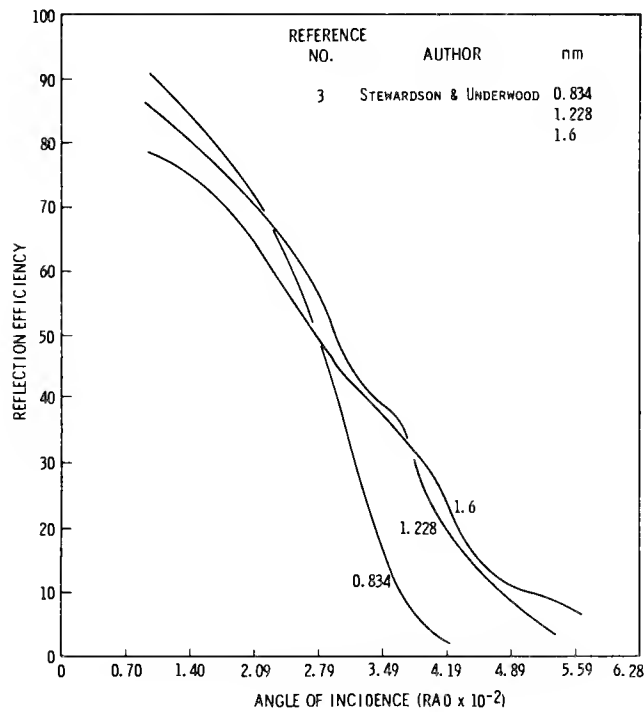


FIGURE 12. Reflection curves for stainless steel.

Nickel

Ershov et al. [4] using a diffraction grating to monochromate the X-ray beam made reflection efficiency measurements of nickel at wavelengths including 0.834, 0.989, 1.044, 1.225, 1.334, 1.597, 1.759, 1.945, 2.164, 2.362, 2.478, and 4.44 nm. The reflection efficiency curves for 0.834, 2.478, and 4.4 nm are given in Figure 13.

Copper

Samples of 10- and 20-nm copper films deposited on glass substrates were tested at a wavelength of 0.832 nm by Hendrick [2]. The reflection efficiency curve for the 20-nm film is plotted in Figure 14.

Germanium

Ershov et al. [4] made reflection efficiency measurements on germanium at wavelengths including 0.834, 1.225, 1.334, 1.456, 1.597, 1.759, 1.945, 2.164, 2.362, 2.478, and 4.44 nm. The reflection efficiency curves for 0.834 and 2.478 nm are given in Figure 15. Lukirskii et al. [9] determined the reflection curves for wavelengths including 2.36, 4.4, and 6.7 nm. The curves for 4.4 and 6.7 are shown in Figure 15.

Silver

Silver films 10- and 30-nm thick were deposited onto glass substrates and the reflection efficiency curve was determined at a wavelength of 0.831 nm by Hendrick [2]. The reflection curve for the 30-nm-thick film is given in Figure 16. Lukirskii et al. [9] made reflection efficiency measurements at wavelengths including 2.36, 4.4, and 6.7 nm.

Reflection Efficiency

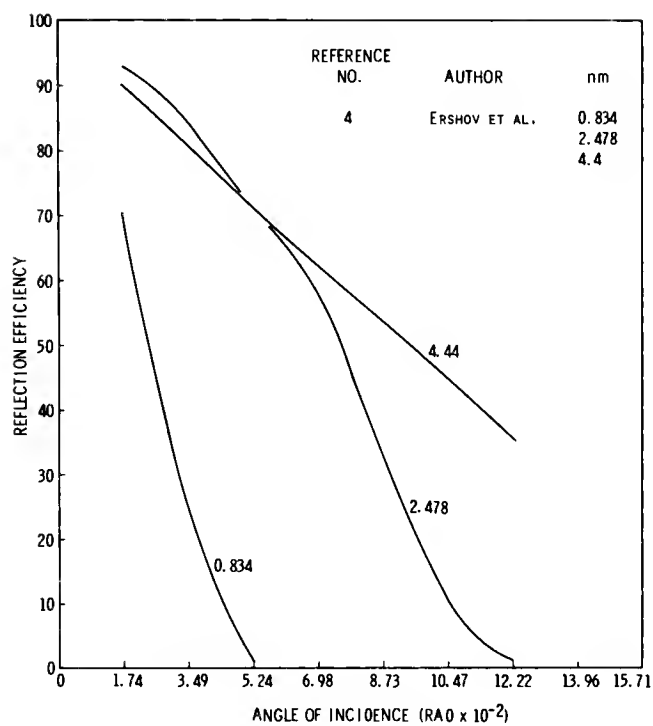


FIGURE 13. Reflection curves for nickel.

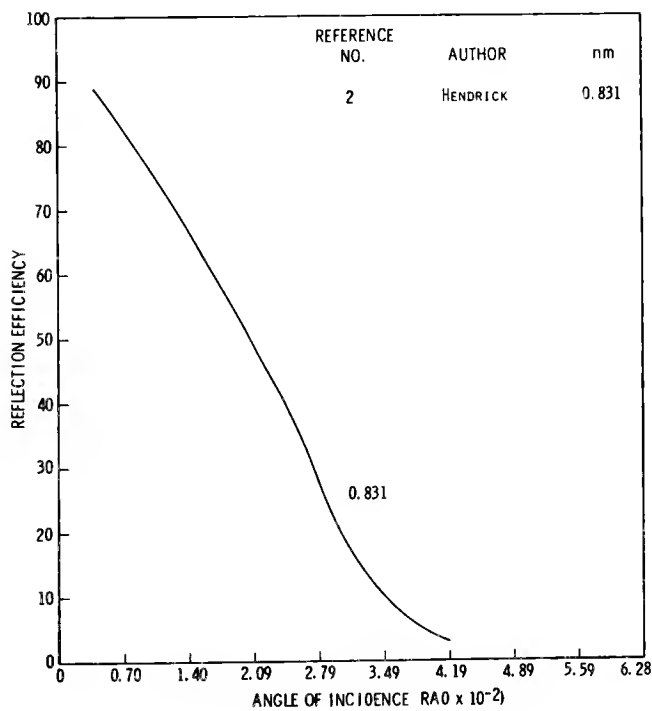


FIGURE 14. Reflection curves for copper.

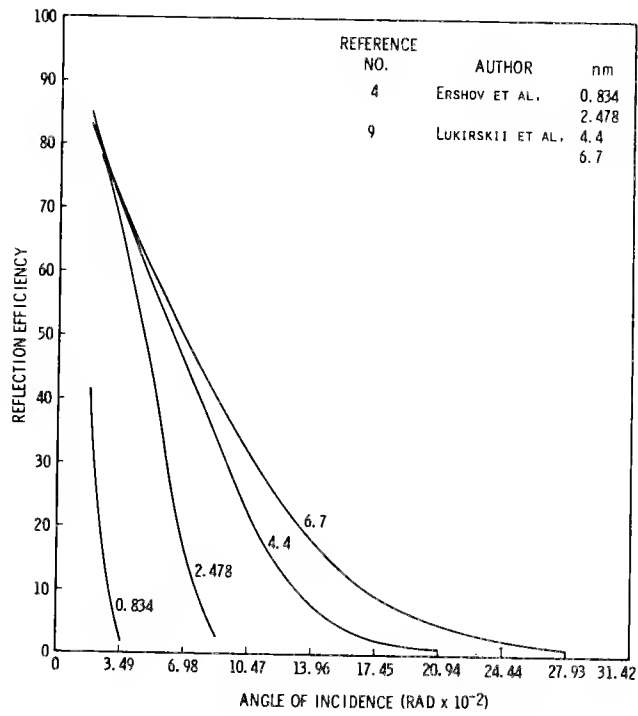


FIGURE 15. Reflection curves for germanium.

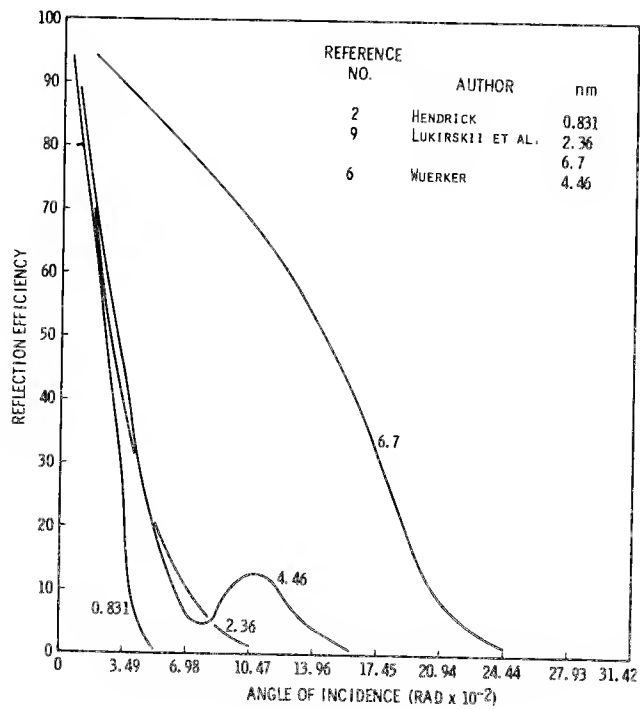


FIGURE 16. Reflection curves for silver.

Reflection Efficiency

The curves for 2.36 and 6.7 nm are given in Figure 16. Wuerker [6] studied the reflection of silver at 4.46 nm (Fig. 16).

Gold

Hendrick [2] vacuum deposited 21.1 and 42.4 nm of gold on glass substrates and made reflection efficiency measurements at a wavelength of 0.832 nm. The reflection efficiency curve for the 42.4-nm film is plotted in Figure 17. Reflection efficiency measurements were made at wavelengths including 0.831, 1.044, 1.225, 1.334, 1.456, 1.597, 1.759, 1.945, 2.164, 2.352, 2.478, and 4.44 nm, by Ershov et al. [4]. The reflection curve at 2.478 nm is given in Figure 17. Johnson and Wuerker [5] measured the reflectance of an evaporated gold film on a glass substrate at a wavelength of 4.46 nm (Fig. 17). Wuerker [6] also reported the reflection efficiency of gold at 4.46-nm radiation. The reflection efficiency of gold at several wavelengths including 2.36, 4.4, and 6.7 nm was measured by Lukirskii et al. [9]. Their results for 6.7 nm radiation are given in Figure 17.

Polystyrene

Lukirskii et al. [9] prepared a polystyrene layer by heating a glass billet in a 1.5 percent solution of polystyrene in toluene. The reflection efficiency was measured at several wavelengths including 2.36, 4.4, and 6.7 nm (Fig. 18).

KCl

Lukirskii et al. [9] deposited KCl on a glass billet which has been

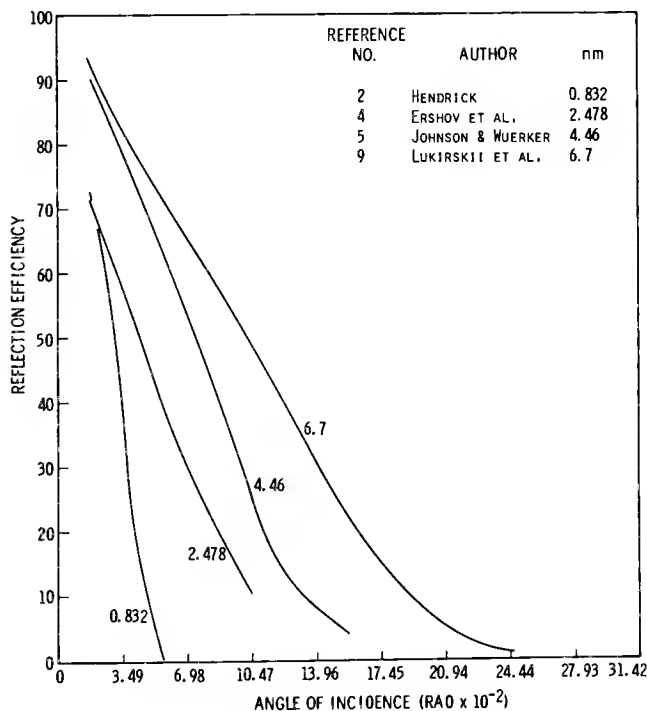


FIGURE 17. Reflection curves for gold.

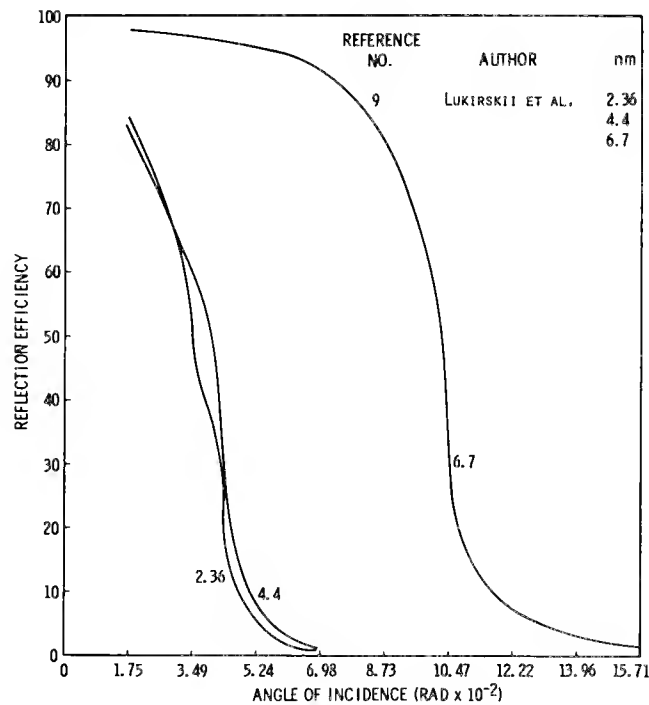


FIGURE 18. Reflection curves for polystyrene.

coated with a conducting film. The reflectance was measured at wavelengths including 2.36, 4.4 and 6.7 nm (Fig. 19).

SrF₂

Lukirskii et al. [9] deposited SrF₂ on a glass billet containing a conducting film and measured the reflection efficiency at wavelengths including 2.36, 4.4, and 6.7 nm. The results are given in Figure 20.

MgF₂

Lukirskii et al. [9] measured the reflection efficiency of MgF₂ at wavelengths including 2.36, 4.4, and 6.7 nm (Fig. 21). The sample was prepared by depositing the MgF₂ layer onto a glass billet containing a conducting film.

LiF

Lukirskii et al. [9] deposited a layer of LiF onto the conducting film on a glass billet and measured the reflection efficiency at wavelengths including 2.3, 4.4, and 6.7 nm. The reflectance curves are shown in Figure 22.

SUMMARY

In the literature reviewed, experimental reflection efficiency curves for 20 materials were found for the radiation wavelength ranges of

Reflection Efficiency

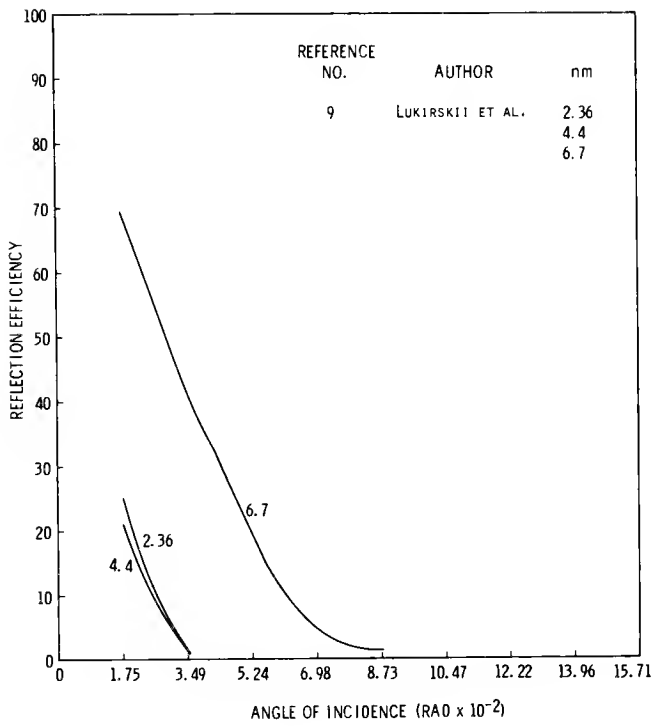


FIGURE 19. Reflection curves for KCl.

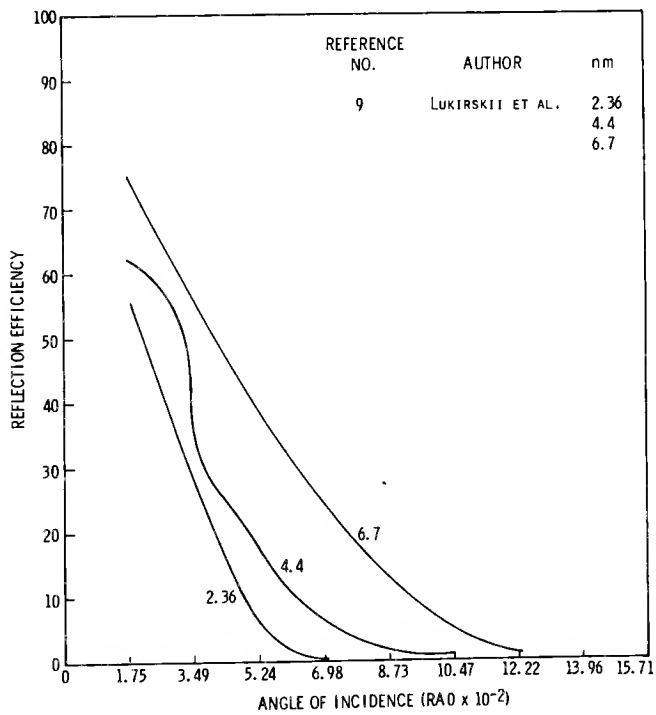


FIGURE 20. Reflection curves for SrF₂.

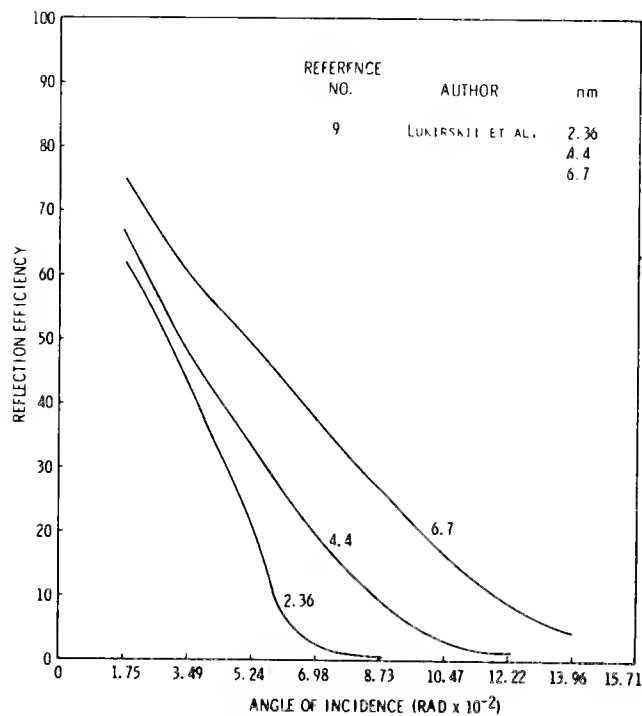


FIGURE 21. Reflection curves for MgF₂.

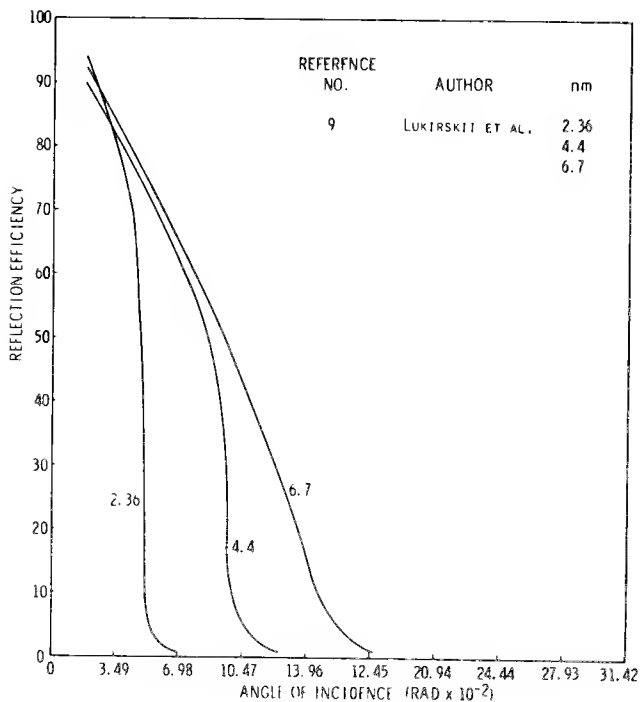


FIGURE 22. Reflection curves for LiF.

Reflection Efficiency

0.8 to 2.5 nm and 4.4 to 8 nm. Many of the experimenters also reported data for radiation outside of the range selected for this paper. To give a representative picture of the reflection efficiency as a function of incidence for the range of wavelengths studied, curves have been prepared for each material reported.

LITERATURE CITED

1. Reynolds, J. M. 1971. A vacuum X-ray reflectometer. *Ala. Acad. Sci.* 42(4):253-263.
2. Hendrick, R. W. 1957. Spectral reflection of solids for aluminum K radiation. *J. Opt. Soc. Am.* 47:165-171.
3. Stewardson, E. A., and J. H. Underwood. 1965. The reflection of soft X-rays by polished surfaces of glass and steel. *Brit. J. Appl. Phys.* 16:1877-1884.
4. Ershov, O. A., I. A. Brytov, and A. P. Lukirskii. 1967. Reflection of X-rays from certain substances in the region from 7 to 44 Å. *Opt. Spectry.* 22:66-69.
5. Johnson, G. L., and R. F. Wuerker. 1963. Reflectance measurements at carbon K and beryllium K wavelengths. *X-Ray Optics and X-Ray Microanalysis*. H. H. Pattie, V. E. Cosslett, and A. Engstrom, ed. Academic Press (New York and London). 229-239.
6. Wuerker, R. F. 1960. Spectral reflectance by solids of carbon K radiation. Ph.D. Dissertation. Stanford University.
7. Lukirskii, A. P., and E. P. Savinov. 1963. Reflection of ultra-soft X-radiation from glass and titanated surfaces. *Opt. Spectry.* 14:152-154.
8. Dershem, E., and M. Schein. 1931. The reflection of the $K\alpha$ line of carbon from quartz and its relationship to index of refraction and absorption coefficient. *Phys. Rev.* 37:1246-1251.
9. Lukirskii, A. P., E. P. Savinov, O. A. Ershov, and Yu. F. Shepelev. 1964. Reflection coefficients of radiation in the wavelength range from 23.6 to 113 Å for a number of elements and substances and the determination of the refractive index and absorption coefficient. *Opt. Spectry.* 16:168-172.

INDEX

Actinides, spectroscopic investigations of the flourenyl derivatives of	153
Adams, Franklyn W.	130
Adams, Murray	180
Adrenal stress during estrus, pregnancy, parturition, and lactation in white rats	148
Agribusiness potentials and problems in North America	176
Alabama image, problems and progress	47
Alcohol dehydrogenase from <i>Euglena gracilis</i> , some properties of	137
Algae, green, in Mobile, Alabama	123
Algal cell size, effect of strontium substitution for calcium	148
Alloy steels, heat treated, an evaluation of toughness based upon energy dissipation	191
Anderson, Frank Y., IV	174
Anderson, M. H., Jr.	172
Ante-bellum Alabama, some French views of	186
Antennas, umbrella; characteristics of -- a method of moments solution	192
Antibody production against rattlesnake venom in rabbits	133
Archaeology, artic, its relevance in terms of man's prehistory in the New World	199
Archaic influence seen in Bayou La Batre phase site, Clark County, Alabama	196
Archaic site in Autauga County, Alabama: Jacob's Swamp	197
<i>Aspergillus ochraceus</i> , effect of time, temperature, pH, and aeration on ochratoxin A production	146
<i>Aspergillus ochraceus</i> , isolation of a new metabolite from the culture medium of	142
Atwood, J. L. 151, 152, 153, 155,	157
Azides, anionic organoaluminum, structural studies of	152
Baklanoff, Eric N.	174
Barfield, B. F.	195
Barite in Calhoun County, Alabama, occurrences and associated structures of	163
Barras, Donald J.	130
Bartelme, Lois	200
Beam, H. Wayne	131
Beatty, Paula	17
Benson, George L.	144
Bentley, Robert D.	158
Benton, Cole	137
Biological systems, an engineering approach to	194
Biostratigraphy, palynofloral, statistical approach, Coker Formation (Upper Cretaceous), Western Alabama	160
Biota of the Mobile Bay estuary, effect of river discharge	150
Birds, winter, Wheeler National Wildlife Refuge, 1970-1971	149
Bishop, Everett L.	131
Bishop, Sally L.	139

Index

Blackburn, R. F.	192
Body build and body-image of parents and children, relationships between	199
Bogan, Carolyn	150
Boggess, R. K.	158
Bonham, Harriett Joanne	168
Boron deficiency in <i>Hibiscus rosa-sinensis</i>	126
Bourne, John R.	132
Brockman, George F.	159
Brown, Jack S.	132
Brugh, Thomas H., Jr.	133
Cabler, Jennie L.	133
Cahoon, Elizabeth	159
Canning company, King Pharr	170
Carrington, Thomas J.	160
Carroll, B. D.	187
Causey, M. Keith	28
Cave, Pinson, a recapitulation	200
Ceramic materials, fracture strength under combined stresses	188
Cercopinae, comparative morphology study of five tribes of	135
Chafin, Brenda R.	134
Chase, David W.	196, 197
Chen, M. S.	154
Chile, failure of the middle class	182
Chloromercuriferrocene and trimethylaluminum, synthesis and structure of the adduct of	151
Chloroplasts, separation in density gradients	134
Christopher, Raymond A.	160
Church, down-town, in social change	181
Cities, Alabama, unifunctional classification of	169
Clark, Otis M., Jr.	161
Cline, George B.	134, 136, 145
Clothiaux, E. J.	173
Coal reserves in Alabama, problems of estimating	102
Coal reserves in Alabama, remaining recoverable, facts regarding the distribution of	166
Cochis, Thomas	126, 135, 140
Cochran, J. E.	187
Collins, R. J.	136
Collogen fibrils, isolation from diseased human periodontium by zonal centrifugation	145
Colonial instability, New Jersey as a test case	183, 215
Communications, optical, for space applications	194
Computer-aided digital filter design	190
Computers, a minicomputer system for education purposes	189
Computer, software problems and their solutions associated with a Varian data system 620/i computer interfaced to an ESR spectrometer	151
Coniferous wood from the Tuscaloosa outcrop area in Alabama and Georgia	159
Consumer problems in Alabama, current status of	174
Cook, W. J.	151

Journal of the Alabama Academy of Science

Coon, Donald M.	22
Costes, Danice Heartsill	135
Cotton harvesting, selection of optimum capacity using an inventory model	191
Couch, Richard	177
Croker, Thomas C., Jr.	168
<i>Ctenus hibernalis</i> , notes on the nitrogen excretion in the spider	137
Curl, E. A.	131, 144
Curren, C. B., Jr.	198
Cutshell, Euel R.	153
Cyanide, determination of by fast sweep polarography	153
Dagg, Martha K.	134, 136
Darden, William H., Jr.	149
Davenport, Sally	151
Davis, Grant M.	54
Davis, Norman D.	142, 146
DeBrunner, L. Earl	169
Demster, S. W.	188
Denton, T. E.	17
Development program, tributary area, Tennessee Elk River counties, an evaluation of program activities	176
Dickinson, Harry E.	181
Diener, Urban L.	142, 146
Digital circuits, fault detection	187
Digital filter implementations	195
Dills, Gary	204
Dixon, Carl F.	147
Dog, prehistoric remains showing evidence of pulmonary osteoarthropathy	196
Douty, Helen	199
Doves and blackbirds, competition for available grain	22
Dunkelberger, John E.	181
Elastic deformation of N-phase composite solids, graphical approach	81
Elastic deformation of N-phase composite solids, rectangular approach	94
Electron spin resonance spectra, simulation of liquid crystalline-type, theoretical consideration and model of preferred averaging	155
Ely, Richard E.	188
Emplaincourt, Jacques	169
Engleman, Catherine	152
Environmental crisis in sociological perspective	181
Enzyme, amylase, activity of soil in relation to season and cultural practice	144
Enzyme, aryl phosphomonoesterase, activity of soil in relation to season and cultural practice	144
Enzyme, leucine aminopeptidase, kidney, structural studies	154
Ephemeris generator, Earth orbital, for preliminary design applications -- an approximation technique	188
<i>Epistylis</i> , a symbiont on the stinkpot	132
Erdey, Michael R. A.	81, 94

Index

<i>Ergasilus wareaglei</i> , copepod from North American catostomid fishes	243
ESR data recorded on magnetic tape, determinations of peak positions and line shape functions	152
ESR spectra, rapid decaying, on-line acquisition of	156
ESR spectra of α -chloro organic radicals, the for- bidden transition and its role in	154
ESR splittings, temperature dependent, density matrix technique applied to the calculation of	150
Evergreens, cultivated plants of northeast Alabama	135
Excavation near Wilsonville, Alabama	198
Excavations under St. Peter's basilica	203
Farb, Roderick	137, 138
Faunal collection, the story of	198
Fenn, Hollis C.	178
Fields, Stanley A.	66, 172, 264
Fishes, Lower Cretaceous pycnodont from Texas, jaw mechanics and paleoecology	167
Fishes of Alabama, rare, endangered, and depleted freshwater	170
Fishing techniques, salt-water, adaptations of to the local environments in two groups of eastern Australia	202
Fluid inclusions in barite and fluorite from Bibb County, Alabama	163
Forest ecology of northwest Alabama	140
French, G. W.	188
Fromhold, A. T., Jr.	172
2-furanylmethyl radical, experimental and theoretical electronic distribution	156
β -galactosidase activity, determination by a modification of the p-nitrophenyl- β -D-galactopyranoside method	131
<i>Gambusia affinis</i> , effects of X-irradiation in tail fin	17
Gardner, Elizabeth	182
Geology, Appalachian ore deposits and continental drifting	161
Geology, environmental, in Alabama	164
German, E. R.	162
Gibson, R. H.	176
Glossosomatidae, biological studies of the family in northwest Alabama	132
Goss, J. B., Jr.	152
Graf, E. R.	189
Green, Margaret	147
Griffith, Mitch	134
Hains, C. F.,.....	153, 162
Hardin, Michael E.	170
Harris, Catherine T.	182
Hartwig, Chester W.	183, 228
Harwell, Kenneth E.	190
<i>Heliothis zea</i> , physiological interrelations with two larval parasitoids	130
Henderson, H. A.	176
Herpetofaunal provinces of Alabama, a mathematical model	130
Heterolysosome formation and function in some anurans	141
Highway safety program, organizational disunity	54

Journal of the Alabama Academy of Science

Himes, Samuel H., Jr.	47, 174
Hollinger, Frank O.	162
Hollis, Nancy	198
Holt, William C.	189
Hood, Ronald D.	138, 139
Hughes, Travis H.	163
Hyde, L. W.	164
(¹⁴ C)-5-hydroxytryptamine as related to intestinal contractility, autoradiographic analysis	143
Impact structure, probable, near Wetumpka, Alabama	158
In-depth topic, research for elementary school science	180
Infra-red studies of pressure effects occurring in KBr pellets	158
Iron bacteria and Alabama water supplies	147
Irving, Thurman A., Jr.	189
Isbell, Raymond E.	153
Johnson, Joseph E.	189
Johnson, Sterling K.	243
Joines, Karen	198
Jones, Daniel D.	139
Kermani, T.	183
Kinsaul, Regina J.	139
Kispert, L. D.	150, 151, 152, 154, 156
Lake, James E.	178
Lalor, William F.	191
Landers, Kenneth E.	126, 135, 140
Lanthanides, spectroscopic investigations of the flourenyl derivatives of	153
Lines, Gregory C.	158
Lioy, P. J.	173
Liu, C. K.	195
Loomis, J. M., III	189
Lunar rocks, are they igneous in the same sense as earth rocks?	166, 248
Lynch, Bob	163
Macrobenthic organisms, a survey in an industrial discharge embayment	132
Maicoba, a village to be studied, District of Yecora, Sonora, Mexico	202, 237
Manger, Elizabeth	178
Manger, Martin C.	178
Mannich, H. A.	147
Marine environments, maintainance of a closed circuit system	131
Market of Ticul, Yucatan, anthropological aspects	200
Markets, rural, some parallelisms in -- Ticul, Yucatan, Mexico and Northport, Alabama	200
Marriage and divorce in Alabama, changing patterns in	186
Martin, Elizabeth F.	178
Masada -- Watchword of a nation	198
McCarl, Henry N.	174
McCay, T. Dwayne	190
McCreary, John R.	183, 215

Index

McIntyre, Sherwood C.	28
Meander belt deposit in the Tuscaloosa group (Upper Cretaceous) in Lee County, Alabama	163
Mego, J. L.	137, 141
Melius, P.	154
Merkel, Susan	199
Meroney, Nancy	163
Meteor trail radiation	190
Miller, Ronald I.	190
Milton, P. A.	155
Middle East, peace in	183
Miller, Margaret W.	123
Mining and society in an urban environment, designing a study of the interaction between	174
Mining, U.S. copper mining investments in Chile, 1945-1970	174
Moore, B. G.	137, 138
Moore, Jack H.	142
Morgan, Alice Hardin	142
Moser, Paul H.	164
Moss, Samuel W.	148
Myers, John B.	184
Nagle, H. Troy, Jr.	189, 190, 195
Neathery, Thornton L.	158
Nematodes, effect of crop rotation and fertilizer treatments on populations of	136
Nesbitt, Paul H.	200
Newala limestone, petrography of	3
Newton, J. G.	164
Nieberlein, Vernon A.	155
<i>Notropis ardens</i> , hematological studies of	143
Oakley, Carey B., Jr.	200
Occupational work structures, values, and use of leisure	180
O'Kelley, Joseph C.	148
Old, Christopher W.	143
Organoscandium chemistry, new developments	157
Ornamentals in the Mobile area, survey of diseases of	148
Oxidation rates on (100) faces of copper and nickel single crystals, experimental studies of	172
<i>Pagurus longicarpus</i> Say, study of combined temperature and salinity levels in the hermit crab	146
Parametric hydrology, geologic index	162
Parasites, a survey of the internal parasites of a feral herd of fallow deer in Alabama	133
Parasites in first grade children in Dale County, Alabama, a quantitative and epidemiological survey	147
Parks, Alabama state	171
Pell, Kynric M.	189, 194
Petrogenesis of an exposure of the Camp Hill granite	162
Pietrzak, T.	155
Pine, longleaf, Alabama -- land of the	168
Pittman, C. U., Jr.	156
Plant uses in Mexico and Peru in Pre-Columbian times	203

Journal of the Alabama Academy of Science

Planz, E. J.	191
Plasma discharges, a coaxial, high-voltage switch for	173
Pollution and its distribution in Mobile Bay, a preliminary investigation of	138
Pollution, thermal, near the junction of two confluent streams	195
Population densities, critical, with respect to Africa south of the Sahara	171
Power divider, C-band reactive stripline	189
Protein from gas-vacuole membranes of the blue-green alga, <i>Microcystis aeruginosa</i> , characterization of	139
Pruett, Jerry	156
Pseudohalides, organogermanium, reaction of with aluminum alkyls	157
Quail, insecticide residues in	28
Quattrochi, Linda	143
Quijano, R. C.	156
Raney, Donald C.	194
Ramsey, John S.	170
Reaction chemistry in the $K[Al_2(CH_3)_6SCN]$ melt	155
Reconstruction, the Alabama freedmen and the economic adjustments	184
Reed, Carolin June	170
Reflection efficiency of various materials in the X-ray regions of 0.8 to 2.5 nm and 4.4 to 8.0 nm	172, 264
Reynolds, John M.	73, 173, 253
Riggsby, Dutchie	179
Riggsby, Ernest D.	180
Roberts, D. H.	157
Rodriguez-Kabana, R.	131, 136, 144
Ryel, Elaine M.	145
Ryel, Richard B.	145
Sanders, Donald Wayne	191
Sansing, Gerald A.	146
Satellite, long-term effects of gravity-gradient torque on the rotational motion of a triaxial artificial earth satellite	187
Saunders, Grady	194
Scarborough, Leon	165
Searcy, Margaret Z.	202, 237
Seismograph/clinograph, horizontal, with electro-optical transducer	159
Self, R. L.	148
Service economy, expanding, some implications of	175
Sheldon, Elisabeth Shepard	202
Sherman, Merle	171
Shirley, Marian V.	175
Shotts, Reynold Q.	10, 102, 166, 248
Silicestone of the Fort Payne formation, petrography and weathering	167
Silvicultural system, clearcutting	169
Sinkhole problem, in and near Roberts Industrial Subdivision, Birmingham, Alabama, a reconnaissance	164

Index

Site selection for induced infiltration along the Alabama River, evaluation of techniques, conclusions and accomplishments	165
Smith, C. E.	192
Smith, C. Earle, Jr.	203
Smith, K. D.	157
Smith, Roger E.	144
Snyder, George H.	126
Space station experiments	190
Space stations, orbital, preliminary design requirements -- an application of a computer simulation model	188
Stackman, Harvey A.	146
Stanfield, Joseph W.	194
Stearns, Richard G.	167
Stellar X-ray observations, summary of recent	173
Stinnet, J. D.	147
Stork, Roger LaDon	147
Stovall, James R.	171
Streamflow quality, related to rock type by using specific conductance parameters	162
Strickland, A. J., III	175
Strongyloid infection in the domestic rabbit, some aspects of the immunology of	147
Stuart, Jeanne J.	147
Student values, changes during two years of college	118
Subirats, F. J.	148
Sutherland, Dixon	203
Talladega group, Chilton County, Alabama, further data on the	160
Teachers, help for the secondary science teachers of Alabama summer institutes	178
Teaching, Audio-tutorial of biology in a small school situation	177
Teaching, kinestasis and chronocompression as techniques in science teaching	179
Teaching, study of microteaching in the in-service education of teachers of elementary science	178
Teratogen, characteristics of arsenite as a	138
Teratogenesis in mice, sodium arsenate induced	139
Testing, oral, of non-readers in science, continuing study of	179
Thermal responses, telemetered, of the Virginia opossum	204
Thomas, Jerry P.	148
Thurmond, John T.	167
Till, Margaret	148
Tourist departures from eight southern states to Jamaica, a forecast model	175
Trade, wholesale, in Tuscaloosa, Alabama, geographic extent of ...	168
Transportation vehicles, surface, aerodynamic forces on	194
Tucker, Robert G.	149
Tungsten containing dissolved oxygen, oxidation in air of	155
Turner, Charlie D.	194
Serotonin, glycogenolytic effect in the intact animal	142

Journal of the Alabama Academy of Science

Urban character of Decatur, Alabama, analysis of the evolution of	170
Vacuum X-ray reflectometer	173, 253
Value, a sociological concept reconsidered	183
Value issues in sociology and science	228
<i>Vejovis carolinianus</i> , notes on nitrogen excretion in the scorpion	137
Virus of the cotton bollworm, fractionation and analysis studies of components of the nuclear polyhedrosis virus	145
<i>Volvox aureus</i> M5, study of development and nucleic acid synthesis during the life cycle of	149
Water-borne particulates, distribution analysis by zonal centrifugation	134
Water in abandoned mines, mineral resource in Alabama	10
Weathers, Glenn	194
Weaver, H.	173
Weber, Bernerd C.	186
Weber, Max, theoretical implications on patterns of religious and political involvement	182
White, Henry E., Jr.	186
White, Ronald	190, 195
Wilkerson, Shirley	17
Williams, Gerald G.	176
Williams, George, Jr.	149
Williams, Louis G.	150
Wilson, John M.	167
Wilson, Robert M.	34, 173
Wind tunnel studies of aerodynamic interaction between C.O.E. trucks and cars	189
X-ray optical systems	66
X-ray sources, descriptive survey	34
X-ray wavelengths, reflection	73
Yeager, David W.	3
Yeates, John W.	118
Young, Harold C.	176
Yuan, Cheng-Hsien	195
Zatko, D. A.	158
Zonal rotor, evaluation of the RK-II Flo-Band zonal rotor	136







(76.1)B

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

**AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE**

**OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830**

VOLUME 43

**JUN 8 1973
JANUARY, 1972**

NUMBER 1

LIBRARY
**THE AMERICAN MUSEUM
OF NATURAL HISTORY**

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

**AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE**

VOLUME 43

JANUARY, 1972

NUMBER 1

EDITOR

Elroy A. Curl
Auburn University

ARCHIVIST

Clyde H. Cantrell
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman
Auburn University

Elroy Curl
Auburn University

Ann Everett
Plainview High School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ARTICLES

Occupational Work Structures, Occupational Values, and Use of Leisure Murray Adams	3
The Uses of Game Theory in Social Science Education: A Humanistic Perspective Patrick Ferguson	9
Alabama — Land of the Longleaf Pine Thomas C. Croker, Jr.	14
Bacteriological Survey of Freshwater Fishes of the Tensaw River, Alabama Sterling K. Johnson and Ernest H. Williams, Jr.	18
The Clearcutting Silvicultural System L. E. DeBrunner	23
Patterns of Religious and Political Involvement: Theoretical Implications from Max Weber Catherine T. Harris	32
A Summary of Recent Cosmic X-Ray Observations Robert M. Wilson	41
Telemetered Thermal Responses of a Specimen of the Virginia Opossum Gary Dills	55
President Warren G. Harding's Birmingham Address Jacquelyn M. Diener	63

Occupational Work Structures

OCCUPATIONAL WORK STRUCTURES, OCCUPATIONAL VALUES, AND USE OF LEISURE

Murray Adams
Department of Sociology
Auburn University, Auburn, Alabama

Today and in the very near future we are encountering what may be labeled a "leisure crisis." Faced with larger blocks of leisure time to which a population is unaccustomed, leisure may well be a serious social problem. It is with this fact in mind that sociologists have in recent decades turned their attention to leisure and understanding some of its dynamics.

Our present exploratory research from which this paper originates focuses on the relationship between occupation, values, and use of leisure patterns when comparing college faculty members from different academic fields. In constructing a theoretical model linking these three variables a number of questions arise which are both vexing and frustrating. The chief difficulty is achieving conceptual clarity and operationalizing the concepts used. This presentation poses in brief some of the main theoretical and methodological issues we have encountered.

Initially there is the difficulty in understanding and distinguishing between work and leisure. In writing of the relationship between these two variables, Erwin Smigel has said:

In our society, work and leisure have always been inter-related. Automation and the possibility of additional free time have caused some concern about how this time will be used; how it will change society. One fear is that many people are not properly trained to know what to do with additional leisure time. Other problems arise involving changing work conditions and leisure. William A. Faunce discusses those most directly affected by automation. Berger, and Weiss and Riesman mention many others ...The problem of planning for leisure time, which worries Weiss and Riesman, involves most of the same difficulties encountered by researchers in the field. Perhaps the greatest handicap that besets planning stems from the value system, which frowns on society arranging for leisure, and from a lack of tradition of leisure which hinders creative thinking about leisure decision-making.¹

While much attention has been given to the so-called "central life

¹Erwin O. Smigel (ed.), *Work and Leisure: A Contemporary Social Problem* (New Haven: College and University Press, 1963) from the Introduction.

interests" of specific occupational groups,² little attention has been focused on occupational values as a causal factor in the use of leisure. One notable exception is the work of Gerstl. In his article, "Leisure, Taste, and Occupational Milieu," Gerstl indicates that use and type of leisure is not totally determined by social class, in fact, when occupation is considered as an intervening variable social class provides a somewhat spurious explanation for the use of leisure. He argues instead that membership in an occupational setting is one of the most crucial factors to be considered. He quite adequately made his point by a comparison of three professional groups and their different leisure patterns.³

When attempting conceptual clarity between work and leisure the basic problem - put simply - is that it is difficult to draw a line of demarcation between where work ends and leisure begins. Does the political scientist cease to be a political scientist when he reads the weekly news periodical or watches a television news program? On the surface these activities may appear to be leisure-time pursuits since they are not recognized as "work tasks"; however, they may represent for the political scientist an opportunity for content analysis based on his expertise as a political analyst. To further confound this immediate problem there is the fact that most persons are not able to make these kinds of distinctions.

Leisure in our culture is a block of time while work refers to a type of activity. Leisure becomes activity only in the sense that it can be interpreted as those activities one does in his free time. But now the question becomes - what is free time? Certainly, it is not all the maintenance activities we are so frequently engaged in when not at work - nor is it those things we are required to do by our associates. Conceivably leisure might then be what a man does after he has met all these requirements. Frequently work is carried over into what is considered leisure time or away from the work setting particularly among professionals and managers, and then it is extremely difficult to make a distinction between the two. What passes as leisure activity may be defined by the individual as work.

There are a number of organizations or associations which are designated as sources of leisure activities. However, it is not easy to know what particular function such activities actually accomplish. This can be seen in cases where attempts are made to classify voluntary associations on the basis of their stated functions. If, for example,

²Robert Dubin, "Industrial Workers' Worlds: A Study of the 'Central Life Interests' of Industrial Workers," *Social Problems*, III (January, 1956), 131-141. Also see Lewis H. Orzack, "Work as a 'Central Life Interest' of Professionals," *Social Problems*, VII (1959), 125-132.

³Joel E. Gerstl, "Leisure, Taste, and Occupational Milieu," in Erwin O. Smigel, *op. cit.*, 146-167.

Occupational Work Structures

Babchuk and Gordon's⁴ typology of voluntary associations is used including instrumental, instrumental-expressive, and expressive associations, and judges are asked to classify various organizations into one of the three categories, contradictions in the rankings obtained are numerous. To further illustrate this point one might ask the individual who hunts on week ends: Do you hunt to be alone, to enjoy nature and the out-of-doors, for the companionship derived from hunting from someone else, to get food, or to develop a skill at hunting as a sport? The responses to this question would be varied indicating different preferences or values.

The central point in our present research is that occupations stress particular value orientations and that these are manifest in leisure patterns. Occupation was chosen instead of work for a number of reasons. Work traditionally is defined as onerous activity suggesting a negative value associated with it. Those activities which are unpleasant are work. This contrasts sharply with the interpretation of work so often connected with the Protestant Ethic - that work is good - what respectable people do - an indication of salvation realized. The way work is sometimes perceived would include activities which are required by an organization or a person in a more powerful position. Similarly there is the interpretation of work we frequently refer to as the Social Ethic which Whyte and De Tocqueville might also call an organization or bureaucratic ethic. This view of work stresses that it is a collective phenomenon and that man needs a sense of belongingness in work which can be found in a bureaucratic or corporate structure.⁵ Therefore, as a class of activities, work becomes unmanageable if these definitions are taken into account, and it seems necessary to focus on some specific criteria in making such a distinction.

Work and occupation have been used interchangeably without a loss of meaning, and since occupation refers to work which is organized, occupation seems like the most conceptually clear and parsimonious means of dealing with work activity. Richard Hall refers to a number of ways occupation is defined ranging from "specific activity with a market value" to work activity to obtain "a steady flow of income" and "the social role performed by adult members of society that directly and or indirectly yields social and financial consequences...."⁶ The definition of occupation which seems most useful is the organization of work activities which does not specify a particular setting or age or objective.

The occupations used in this case are academicians on a university

⁴Nicholas Babchuk and C. Wayne Gordon, "A Typology of Voluntary Associations," *American Sociological Review*, XXIV (February, 1959), 22-29.

⁵W. Lloyd Warner and Norman H. Martin, *Industrial Man* (New York: Harper and Brothers, 1959), 492-493.

⁶Richard H. Hall, *Occupations and the Social Structure* (Englewood Cliffs: Prentice-Hall, Inc., 1969), 4-7.

faculty. The difficulty in dealing with a sample of academicians on the question of values at once is overwhelming since there are to begin with so many sources of variation. To mention a few, there is the question of the academic role defined in terms of teaching and research or as a combination of both and the unique variations which must exist in any setting when compared with others. There is the question of academic subject matter in as much as they do or do not represent unique disciplines with their own peculiar evaluations and expectations of work performance. One has simply to consider engineers in only the most superficial way to note that there exists a definite difference between the engineer as academician as opposed to the engineer employed in industry.

Numerous problems occur in developing or changing disciplines with their attendant variations in stress which accounts for a lack of agreement in values and beliefs. And finally there is the question, perhaps most difficult of all, of a greater set of values or "moral consensus" which the individual brings into his occupation. It was a question Durkheim attempted to answer in *The Division of Labor in Society* through the thesis of functional specialization and moral community. When dealing with occupations as the basis for group constitution and moral integration, Durkheim was mainly describing "professionals" in a stricter sense, and it is this group to which his thesis probably most nearly fits. This sense of moral community is to be seen in the professionals' code of ethics. To consider normative consensus from this standpoint gives maximum emphasis to the argument that occupational structure is the mold for the formation of values. It is through the code of ethics that professions are dependent and sanctioned by the larger society, and it is in this respect that there is a significant carry-over of values from the general social order to the occupational structure.⁷ But can the same be said of other occupational groups? Another relevant question can be raised in this connection if Wilensky is correct: Are professional occupations evolving into a quasi-bureaucratic form and, if so, does this preclude a significant difference in values peculiar to work?⁸ In this case, one can argue as Rue Bucher has that a university setting is not strictly a bureaucratic one.⁹ Of course, this is not to say that university structures do not influence professional areas that are represented there. Such influences can be seen in the funding and differential supportive practices that exist within the university setting.

Finally, and perhaps most frustrating of all, there is the question

⁷C. P. Wolf, "The Durkheim Thesis: Occupational Groups and Moral Integration," *Journal for the Scientific Study of Religion*, IX (Spring, 1970), 17-30.

⁸Harold L. Wilensky, "The Professionalization of Everyone?" *American Journal of Sociology*, LXX (September, 1964), 137-58.

⁹Rue Bucher, "Social Process and Power in a Medical School," in Mayer N. Zald (ed.), *Power in Organizations* (Nashville: Vanderbilt University Press, 1970), 3-47.

Occupational Work Structures

of values. The hazards in separating values, attitudes, and beliefs are of classical renown: Milton Rokeach treats the concept of value as:

...a disposition of a person just like an attitude but more basic than an attitude, often underlying it...a type of belief centrally located within one's total belief system, about how one ought or ought not to behave, or about some end-state of existence worth or not worth attaining. Values are thus abstract ideals, positive or negative, not tied to any specific attitude, object or situation, representing a person's beliefs about ideal modes of conduct and ideal goals. A person's values, like all beliefs, may be consciously conceived or unconsciously held, and must be inferred from what a person says or does....¹⁰

At another point Rokeach indicates values are preferences when he says:

To say that a person has a value is to say that he has an enduring belief that a specific mode of conduct or end-state of existence is personally and socially preferable to alternative modes of conduct or end-states of existence. Once a value is internalized it becomes...a standard or criterion for guiding action, for developing and maintaining attitudes toward relevant objects and situations... and for comparing self with others....¹¹

Lovejoy's definition of value is "...an imperative to action...also a preference for the preferable."¹² This definition is similar to that one used by Parsons and Shils in *Toward a General Theory of Action*. They define values as "...a conception...distinctive of an individual or characteristic of a group, of the desirable which influences the selection from available modes, means and ends of action."¹³

On the basis of these definitions of values we may conclude that a value elicits itself in an expression of preference either in action or statement. But, alas, the world is not so simple, for as Nagel has indicated there are at least two questions which throw doubt on our operationalization of the concept, value. First, there is the problem of reliability when assessing values through verbal means. There is so often a lack of fit between what men "verbally profess" and what they "habitually believe and practice." There is always the known rule but accepted deviance. Moreover, it becomes necessary to assess values not

¹⁰Milton Rokeach, *Beliefs, Attitudes, and Values* (San Francisco: Jossey-Bass, Inc., 1970), 159-160.

¹¹*Ibid.*, 159.

¹²*Ibid.*, 160.

¹³Talcott Parsons and Edward A. Shils, (eds.) *Toward a General Theory of Action* (Cambridge: Harvard University Press, 1951), 395.

simply by verbal statement but also by way of observed behavioral practice. The second question is as yet unanswerable: Do cultural values offer explanations which are perceptively superior in ordering causation than do other explanations using other concepts? As Nagel points out there are as yet no comparative studies to indicate what type of conceptual explanation has the greater merits.¹⁴

Morris Rosenberg in his book, *Occupations and Values*, states that he found certain values were associated with one another forming value orientations. On the strength of this he devised a typology of value orientations comprised of three types: a "people oriented value complex," an "extrinsic reward-oriented value complex," and a "self-expressive-oriented value complex." The three types emphasize respectively a desire to help and work with people, a preference for work with status, prestige, and high rate of income, and a value for work that permits creativity, originality, and the use of special aptitudes.¹⁵ In considering the adoption of this typology our difficulty has arisen over the fact that these orientations are neither mutually exclusive nor exhaustive, and we are left with residual categories such as the individual who prefers work as an end in itself and another with a preference for work which improves the human condition. Our only alternative seems to be an alteration of the typology to include the range of orientations we expect to find.

In conclusion one is tempted to ask if these obstacles are not insurmountable, since we seem to find ourselves in a deep theoretical "pit." Our answer must be that what is simple may not always be adequate and that by raising these issues we reduce the chances of theoretical and definitional premature closure. For as Abraham Kaplan has said:

That a cognitive situation is not as well structured as we would like does not imply that no inquiry made in that situation is really scientific. On the contrary it is the dogmatisms outside science that proliferate closed systems of meaning; the scientist is in no hurry for closure. Tolerance of ambiguity is as important for creativity in science as it is anywhere else.¹⁶

¹⁴Ernest Nagel, *The Structure of Science* (New York: Harcourt, Brace and World, Inc., 1961), 545-546.

¹⁵Morris Rosenberg, *Occupations and Values* (Glencoe: The Free Press, 1957), 16-22.

¹⁶Abraham Kaplan, *The Conduct of Inquiry* (San Francisco: Chandler Publishing Company, 1964), 71.

Uses of Game Theory

THE USES OF GAME THEORY IN SOCIAL SCIENCE EDUCATION: A HUMANISTIC PERSPECTIVE

Patrick Ferguson
Department of Secondary Education
University of Alabama, University

Within the last decade there has been a trend toward the increased use of game-theoretical models in the social science classroom. These models represent an attempt to demonstrate, through mathematical simulation, the most rational behavior to be followed in a decision-making situation. Game theory applications in the social sciences follow the model used by the hypothetical-deductive economic theorists in which rationality is placed within a measured framework.¹ The decision-maker's behavior is considered to be rational when he moves toward his objectives in an efficient manner. This might be expressed mathematically as follows:

Where: X_1 = net value of alternative
 Y_1 = net cost of alternative
 n = other alternatives

Then: $(X_1 - Y_1) - (X_n - Y_n) > 0$

Thus, the individual is rational when he selects the alternative which is least costly.

The game theoretic approach to rational behavior can be illustrated by a classical example from the literature on the subject, The Prisoner's Dilemma, a non zero-sum, two-person game, shown in the following matrix:

		Prisoner B	
		Not Confess	Confess
Prisoner A	Not Confess	5,5	-10,10
	Confess	10,-10	-5,-5

Briefly, the story goes as follows: Two criminals are captured, placed in separate cells, and both charged with the same series of crimes. The evidence is scarce and the District Attorney promises each man that if he confesses he will be set free and given a reward (10), while his accomplice will get the book thrown at him (-10). If the partner also confesses, then both will receive mild sentences (-5,-5). If neither confesses, then both go free (5,5).

The rational strategy is to confess, not because it is the right

¹Game theorists generally recognize the seminal work in the field to be: John Von Neumann and Oskar Morgenstern, *Theory of Games and Economic Behavior*. Princeton: Princeton University Press, 1944.

thing to do, but because confessing is in the best interest of each man. Prisoner A reasons that: "If I confess, then no matter what B does, I will come out better than if I don't squeal." So both confess and get mild sentences (-5,-5). The dilemma is that apparent rational strategy does not maximize value. If the prisoners could trust each other (they are not allowed to communicate) they would both profit from not confessing. However, the game is designed so that each prisoner is tempted to double-cross his colleague.

An analogous situation is the arms race in which both sides could benefit by reducing their expenditures for armaments, but each side could benefit even more by only feigning disarmament while the opposition in fact disarms. The result is that both sides continue to spend vast amounts on arms to play it safe.²

Game theoretic models such as Prisoner's Dilemma can serve useful purposes in the instructional situation. One such use is as a heuristic device for the explanation of problematic situations, such as the arms race in which students can indeed see the dilemma in concrete terms. Another use would be to present students with a problem and its situational utilities for the purpose of having them discover the most rational or "best" solution. A more open ended approach might be to have the students themselves define a problem in terms of its situational utilities, define alternatives, decide upon projected consequences, and make the most rational decision, taking all of these factors into consideration.

Game theory can also be useful in studying problematic situations that have already been resolved, as in historical case studies. The advantage here is that existing data about the actual outcome can be evaluated in terms of its congruence with the prescriptive game theoretic solution.

Other learning outcomes might include the ability to evaluate social scientists' frame of reference in formulating conclusions by attempting to determine the utilities that they have assigned to decision alternatives in the matrix. Game theory can also help the student distinguish between egoistic versus altruistic motives as well as the ability to recognize when a decision-making situation is a zero-sum or a non zero-sum situation.³

²The reader is referred to the expanding literature on game theory for a more comprehensive treatment. Good basic sources include A. Rapoport, *Fights, Games, and Debates*. Ann Arbor: University of Michigan Press, 1960; R. Luce and H. Raiffa. *Games and Decisions*. New York: Wiley, 1957; and the *Journal of Conflict Resolution* which devotes a special section of each issue to gaming theory.

³For a discussion of game theory and its relationship to egoistic and altruistic values see R. P. Wolff. "Reflections on Game Theory and the Nature of Value," *Ethics*: 72: April, 1962, pp. 171-9.

Uses of Game Theory

Proceeding from this brief definition and description of some of the heuristic uses of game theory in teaching social science, let us examine the humanistic considerations. It should be noted here that there have been other efforts devoted to the criticism of game theory. Blackett, Waskow, Maccoby and Riesman, as well as a host of others, have discussed the shortcomings of game theory in terms of its unrealistic assumptions that conflict is limited to two persons, that behavior is always rational, and that interests are always diametrically opposed (zero-sum situations).⁴ In this author's view, Wohlstetter has successfully answered these criticisms and no attempt will be made here to resurrect these issues.⁵ The arguments that follow focus upon the concern that social science courses, in their attempt to teach "good" decision-making exclusively through the use of cost-benefit models of rationality, stand in real danger of failing to provide students with experience and knowledge about the more important and prior humanistic questions.

Bartos has pointed out that game theory represents a normative and not a descriptive approach to decision-making.⁶ It is normative because it tells the actor what action he should take in a given situation. However, game theory tells the decision-maker what he ought to do to maximize his own best interest regardless of whether it is in fact morally correct to act in this way. The prisoner in the dilemma decides to confess not because it is the ethically correct thing to do, but because he sees that it is in his own best interest. The point here is that while game theory is prescriptive rather than descriptive, it prescribes on the basis of what is most prudent rather than what is ethically correct.

The difficulty here of course is that the most significant questions are not those concerned with finding the best means to an end, but of reconciling and deciding among the ends or goals themselves. The most important decisions lie within the realm of the humanistic and our students must not only realize that fact but develop a set of convictions that will guide their behavior. Hopkins has suggested that one way in which the larger moralistic considerations might be taken into account is to have the actor ask himself not only "What is the best decision which will allow me to maximize my own goals?" but also "What if everyone decided to act in this way?"⁷ The difficulty is that there is nothing in the game theory model which calls on the actor to invoke the generalizing principle.

⁴P. M. S. Blackett. "Critique of Some Contemporary Defence Thinking," *Encounter*, April, 1961; A. Waskow. "This Game of Strategy," *New Republic*, February 26, 1962; and M. Maccoby and D. Riesman. "The American Crisis," *Commentary*, June 1960.

⁵A. Wohlstetter. "Sin and Games in America," in M. Shubik, ed., *Game Theory and Other Related Approaches to Human Behavior*. New York: J. Wiley and Son, 1964.

⁶O. J. Bartos. *Simple Models of Group Behavior*. New York: Columbia University Press, 1967, Chapter 15.

⁷R. F. Hopkins. "Game Theory and Generalization in Ethics," *The Review of Politics*. 27: October, 1965, pp. 491-500.

Schelling has noted that because individuals tend to judge situations according to their own goals, there will always be a need for arbitrary laws to guarantee the social as well as the individual good.⁸ The rational game theory model does not provide for the inclusive consideration of value in its social sense. The efforts to apply game theory to ethics by Braithwaite, Schelling, and Hopkins do so within the context of situational ethics.⁹ The fact that the actor may consider the humane implications of his decision is coincidental, and not an integral part of the game theory model.

Another problem concerns the assignment of numerical costs to the payoffs. The criteria for rationality, stated earlier, is the minimization of cost. Exactly what is costly to the actor is a problem that continues to plague the game theorist. In fact it is the central problem when attempting to apply game theory to human behavior. While utility theory has developed into a complex science, the fact remains that prior numerical measurements cannot be assigned with finality. Morgenstern and Von Neumann's hope that the history of the measurement of heat may repeat itself, and that the social utilities that look very unnumerical today may turn out to be measurable in the future, only serves to indict utility theory rather than resurrect it.¹⁰ Until this problem of social measurement is solved, if indeed it can be, game theory will only be able to offer the most meager help in defining social problems.

One further concern is that students who are continually exposed to rational-game theoretical models will begin to believe that we can have the power over the social situation to the extent that it is possible to accurately quantify and simulate the problems of the firm or the international world. They may fail to realize that game theory concerns itself with means and not ends, that real social problems are much more complex and comprehensive, and that the forced choice game theory model is primitively simplistic and unimaginative in comparison to the thinking process undertaken by the human brain in a real situation.

As serious as these deficiencies in the social learning process might be, the most serious gap would be that students would not have considered the relationship between decision-making and conviction. Since game theory and other mathematical behavior models fail to consider the social implications of decision-making, an effort must be made for the extended opportunity to examine social decisions from a humanistic perspective. It is more important that the student know that his decision is a function of his own grounded conviction than to realize that his decision was the most expedient one. Grounded conviction can only come

⁸T. C. Schelling. "Some Thoughts on the Relevance of Game Theory to the Analysis of Ethical Systems," *Journal of Conflict Resolution*, 12: March, 1968, p. 40.

⁹R. B. Braithwaite. *Theory of Games for the Moral Philosopher*. Cambridge University Press, 1955; Schelling, *op. cit.*; and Hopkins, *op. cit.*

¹⁰Von Neumann and Morgenstern. *op. cit.* p. 17.

Uses of Game Theory

from the extended opportunity for humanistic inquiry into the ethical aspects of the problem under consideration. Game theory can not tell us whether we ought to maximize domestic spending at the expense of the space program or whether it was legitimate to intern Japanese-Americans during the Second World War. Hopefully, those making these kinds of decisions would place a higher priority on the humanistic rather than the expedient considerations in deciding upon what action they would pursue.

In concluding, let it be clear that game theory is not being taken to task for not accomplishing what it does not profess to do in the first place. Game theory *has* provided us with a heuristically useful tool for the explanation of rational alternatives and consequences in given social situations; furthermore, we can safely hypothesize that most game theorists would not only recognize the limitations of game theory stated herein but would subscribe to the call for a more balanced approach to decision-making. The purpose of this paper has been to introduce a note of caution about oversubscribing rational models of analysis at the expense of humanistic inquiry. We have already gone too far in convincing students that "correct answers" are possible where none exist. Let us not allow the trend for multiple choice rationality to supersede the larger humanistic questions in the social science classroom.

ALABAMA — LAND OF THE LONGLEAF PINE

Thomas C. Croker, Jr.
U.S. Forest Service
Southern Forest Experiment Station
Brewton, Alabama

Environmental quality is foremost in the minds of the public today and a great desire to improve our environment in this decade of the 70's is under way. There are two major aspects of this national movement. First is the concern about pollution — how to reduce or eliminate air, water and land pollution. Secondly is the positive aspect — how to enhance the livability of our environment by such projects as developing parks, recreational areas, highway beautification and preserving wilderness areas. Trees are universally recognized as a vital component of the quality environment. Not only do they furnish essential products but they purify the air and are highly praised for intangible, aesthetic and spiritual values. Alabama has a unique heritage in the longleaf pine tree.

It is my purpose here to discuss some of the attributes of this tree that make it particularly valuable for building a quality environment in Alabama, and list some action that Alabamians should take to derive greater benefit from this remarkable tree.

Perhaps no other southern tree has a greater potential value for enhancing our environment than longleaf. It has a rugged beauty that surpasses that of the other southern pines. Over the centuries it has been an essential component of many beautiful landscapes around homes, estates, recreational areas, golf courses, and road sides. But even more important than its beauty is an intangible that might be termed heritage value. Since DeSoto tramped through the park-like longleaf forests in search of gold, this great tree has been closely associated with the lives and fortunes of the people of the South.

Early pioneers burned its heartwood in kilns to secure a tar that caulked the seams of wooden ships and water proofed their sails. This enterprise was pursued so vigorously in North Carolina that it is known today as the "tar heel" state. Longleaf yellow pine lumber has framed plantation homes and bridged rivers for armies to cross. Many fortunes have been derived from lumbering these forests. Even today a large number of modern wood-using plants derive a substantial portion of their raw material from the longleaf pine.

Great herds of cattle and livestock have grazed underneath these trees. Hunters, especially those in quest of Bob-White quail, have enjoyed many happy hours here. It would be difficult to find a person in the southern Coastal Plain who directly or indirectly has not been associated with these forests in some way. To many the longleaf pine is woven so intimately into their heritage that the tree has high emotional value to them.

The longleaf pine is not only a tree of great beauty and heritage

Longleaf Pine

value but has numerous utilitarian and ecological attributes. In a region characterized by wildfire, voracious insect and disease pests, violent winds and sterile sandy soils, longleaf is highly resistant to these hazards. It is a prime source of essential wood material such as lumber, poles, piling, softwood veneer, and pulpwood. It is one of the two trees that produce naval stores.

But the white man has ruthlessly exploited and mismanaged the longleaf forests of the Southeast. Today practically all of the virgin timber is gone and the second growth forests occupy only a fraction of the original acreage. Longleaf pine, estimated to occupy more than 50 million acres originally, now grows on less than 15 million acres. Clear-cutting of stands with no provision for regeneration converted thousands of acres to "stump orchards." Razorback hogs destroyed billions of seed and seedlings. Unwise management practices encouraged brush and lower value species to invade much of the original forest. But largely in spite of man some valuable stands of longleaf have sprung phoenix-like from the grass on millions of cutover and scorched acres. This has been largely caused by a fortuitous combination of circumstances where burning happened to come just before a good seed crop and served to prepare a favorable seedbed. Here seedlings grew and survived when the overstory trees were cut. Establishment of good second growth stands has been particularly successful in Alabama where soils and climate are most favorable and the original timber was removed in multiple cuts instead of the one clear-cut that was the rule elsewhere, particularly in Louisiana. However, today many of these fine second growth stands in Alabama are being clear-cut and replaced by slash and loblolly pine.

"Here's to the land of the longleaf pine
The summerland where the sun doth shine."

The poet who wrote these lines was a North Carolinian and he was proudly linking his home state with the longleaf pine tree, but Alabama has a greater claim to the title. Here are some of the reasons.

In the first place, Alabama occupies a central position in the longleaf belt which girds the south from Virginia to Texas. Also, the longleaf pine grows in more physiographic provinces here than in any other state. It is found literally from the mountains to the sea.

In a recent study of seed sources, seedlings grown from longleaf seed collected in south Alabama grew better than those from any other source in the belt. These tests indicate an inherent superiority for the Alabama seed.

Until recently the champion longleaf tree as recognized by the American Forestry Association grew in Autauga County, Alabama. This tree died not too long ago but it has not been surpassed in its vital dimensions.

Foresters have long associated longleaf pine with Alabama. One of the earliest forest working plans developed by the United States Forest Service was for a longleaf forest in the state. This plan, developed

during the Theodore Roosevelt administration under the supervision of the first chief forester Pinchot, was for the Kaul forest near Sylacauga. This forest is today still predominantly longleaf pine, a tribute to the early management policies of the land owner.

Many forest researchers have staked their experimental plots in the extensive stands of Alabama longleaf. One of the earliest growth studies was established in 1934 on land in Baldwin County now owned by the U. S. Steel Corporation. The only research project of the U. S. Forest Service devoting its time exclusively to longleaf pine studies is located at Brewton, Alabama. This station has a 3,000 acre tract of longleaf pine leased for 99 years from T. R. Miller Mill Company for an experimental forest. Pioneer researchers such as Dr. Herman Chapman of Yale University and Dr. Verne Harper, retired research chief of the U. S. Forest Service, have measured and observed longleaf in these forests.

The Society of American Foresters, a few years ago, established a longleaf pine natural area on land now owned by St. Regis Paper Company in Escambia County. This is a virgin tract of longleaf with trees that were saplings when Andrew Jackson's army was in the area early in the 19th century. It is one of only *two* official longleaf natural areas in the United States.

These are only a few of the innumerable cases that could be cited to verify the close association of longleaf pine with Alabama. But Alabama has not taken full advantage of this priceless heritage and there are many ways that this could be improved. I was somewhat startled to learn that Alabama in reality does not have a state tree. Officially the southern pine is credited with this honor but southern pine is really not a tree. It is merely a group of many tree species or, probably more to the point, a term used in the lumber industry for a particular kind of lumber. It certainly would be in order for some organization to sponsor longleaf pine as the state tree.

As I mentioned before, the U. S. champion longleaf pine was located in Alabama but died a few years ago. Now the champion tree recognized by the American Forestry Association is located in Texas. It is entirely possible that an intensive search would reveal in Alabama a champion to de-throne the Texas tree. This should be done.

Despite its many assets longleaf pine does have some liabilities. It is subject to a needle disease known as brown-spot. This disease and other environmental factors can cause a dwarfism that greatly delays height growth. Also longleaf is more difficult to plant than other pine species. Because of these problems very little longleaf pine is planted in Alabama. For example, in the 1969-70 season over 91 million trees were sold by the state nurseries for planting but less than a million of these were longleaf.

Research is finding answers to many of the longleaf planting problems. As this knowledge increases landowners should include more and more longleaf in their planting programs.

Longleaf Pine

Research at the Brewton Station has developed a natural regeneration system for longleaf that has great value in maintaining and improving environmental quality. In applying this shelterwood system a carefully selected stand of large, superior trees is reserved and the remainder of the stand removed. These trees, usually 30 to 60 per acre, not only provide seed for developing the new crop but enhance the landscape and protect the site. Valuable quantities of high quality wood are grown on the trees during the regeneration period. The open woods areas are ideal habitat for quail and provide some supplemental grazing when carefully controlled. Also this system obviates some of the undesirable aesthetic features of such operations.

Many perceptive land owners in Alabama are taking advantage of longleaf to beautify their home grounds and to landscape other locations where aesthetics is important. But there is much more that could be done in this regard. Very few longleaf pines are planted along the interstate highways which criss-cross the state or at schools or other public places. For example, there is not a single longleaf tree on the capitol grounds at Montgomery.

A most unusual opportunity is the possibility of extending the famous Appalachian Trail into the longleaf belt of Alabama. This trail begins in Maine and ends in Georgia. It seems somewhat ironic that while the Appalachian Mountains end in Alabama the trail which follows the crest of these mountains throughout the eastern United States stops in Georgia. Also of particular interest to our discussion here is the fact that the trail could actually be extended into the longleaf type and still be in the high mountains. A good stand of longleaf is located on the side of Cheaha Mountain very close to the highest point in the state. Including the longleaf type would add variety and interest to the Appalachian trail experience.

I have mentioned here only a few ways in which Alabamians can derive a greater benefit from longleaf pine. It is my hope that this discussion will trigger some action so that full advantage of the unique heritage we have in this species can be obtained. With aggressive action our state could soon be known throughout the world as "the land of the longleaf pine."

BACTERIOLOGICAL SURVEY OF FRESHWATER FISHES OF THE
TENSAW RIVER, ALABAMA¹

Sterling K. Johnson and Ernest H. Williams, Jr.
Department of Fisheries and Allied Aquacultures
Auburn University, Auburn, Alabama

INTRODUCTION

This study was undertaken to determine the incidence of systemic bacterial infection which would be present in an assumed healthy natural fish population. Basic knowledge of bacterial infections in healthy fish populations is limited and it is hoped that this work will contribute to a better understanding of the problem.

In North America, several microbiological surveys were made utilizing hatchery fish (Bullock and Snieszko, 1969; Evelyn and McDermott, 1961) and natural populations (in part, Evelyn and McDermott, 1961; Rabb and McDermott, 1962). Two notable European papers, Bisset (1948) and Van der Struik (1965) dealt with characteristic European faunas. Earlier relevant literature was adequately reviewed by these papers, especially the works of Evelyn and McDermott (1961) and Van der Struik (1965).

The present authors sampled fish from apparently healthy fauna of the Tensaw River Drainage, Alabama. This survey differed from others in that it was directed toward healthy non-salmonid fish populations.

METHODS

Beef heart infusion agar² (BHI) and Sabouraud Dextrose agar² (SDA) were used for the isolation of bacteria and fungi.

The fish kidney was chosen as the organ for sampling since it was demonstrated in several studies to usually contain bacteria if bacteria are present in other organs (Van der Struik, 1965). In addition, the kidney is readily accessible in dissection with reduced chance of gut contamination.

A 10-ft seine was used in ten of the eleven collections. One collection was made by the use of rotenone and all collections were made during November and December of 1969. Several habitat types were sampled including river, creek, slough, and estuary.

In all collections, fishes were taken directly from the water and placed alive on ice. Care was taken to ensure that the fishes were not exposed to water that collected at the bottom of the ice containers on the way to the laboratory. All fishes were examined in the laboratory

¹Supported by the Southeastern Cooperative Fish Disease Project (In part by Sport Fish Restoration Funds and Rockefeller Grant No. 65061).

²Difco Laboratories, Inc., Detroit, Michigan.

Bacteriological Survey

within 10 hr of capture.

Upon examination, an attempt was made to select as many fish species as possible from each collection. Two hundred fishes were examined representing 41 species.

Fishes were taken directly from ice and disinfected externally by swabbing with 95% alcohol. The body cavity was opened and a portion of the kidney tissue was removed aseptically and streaked on BHI plates. A portion (1-3 mm³) of tissue was used to lessen the possibility of missing bacteria that might be present in small numbers. In all examinations special precautions were taken to be sure that no cuts in the alimentary canal occurred during dissection.

Twenty-four-hour cultures of the isolates were characterized as follows:

Gram stain	Oxidative fermentative glucose (Hugh and Leifson, 1953)
Motility	
Morphology of slant	H ₂ S production
Cell morphology	Starch hydrolysis
Cytochrome oxidase (Kovacs, 1956)	2,3 butanediol (Bullock, 1961)
	Elaboration of fluorescein (Bacto-Pseudomonas Agar F ²)

If the isolate was Gram negative, motile, short rod, and demonstrated a positive cytochrome oxidase test, it was presumed to be a pseudomonad. Furthermore, bacteria that hydrolyzed starch, produced hydrogen sulfide, were oxidative and fermentative in the glucose medium, and produced 2,3-butanediol were considered *Aeromonas liquefaciens*. Bacteria that did not hydrolyze starch, did not produce hydrogen sulfide, were not fermentative in the glucose medium, and did not produce 2,3-butanediol were designated *Pseudomonas*.

If the isolate exhibited a negative cytochrome oxidase test it was further subjected to the following tests:

Flagella stain (Novel, 1939)	Kligler's iron
Gluconate	Mannitol fermentation
Catalase	Sucrose fermentation
Nitrate	Lactose fermentation
Urease	Maltose fermentation
Simmons citrate	Glucose fermentation
Voges-Proskauer	Litmus milk

Methyl red

Nutrient gelatin

Indol-Nitrate

Lysine decarboxylase

RESULTS

Of 200 fishes examined, 40 (20%) were positive for bacteria (Table 1). Of the 40 fishes infected, only five were infected with more than one bacterial species with a maximum of three in one of the fishes. No fungi were isolated.

Of the 46 cultures obtained, 30 were initially assigned to *Pseudomonas* or *Aeromonas* by the first set of tests mentioned above (Table 2). Of these, five were presumptively identified as *Aeromonas liquefaciens* and although special medium was used for the detection of *Pseudomonas fluorescens*, no *P. fluorescens* was found.

TABLE 1. Incidence of bacteria in hosts.

Result	Number of hosts	Per cent of hosts
Positive	40	20
Positive with two or more bacterial species per host	5	2
Negative	160	80

TABLE 2. Identification of cultures.

Bacterial group	Number of cultures	Per cent of cultures ^a
<i>Pseudomonas</i>	26	57
<i>Aeromonas</i>	5	11
Unidentified	15	32

^aNearest whole per cent.

After the initial sorting, 13 of the remaining cultures were subjected to the second set of tests outlined above. The cultures of this group were not initially given the identity of pseudomonads because they exhibited a negative cytochrome oxidase test. Despite the fact that the isolates were monotrichous Gram negative rods and possessed

Bacteriological Survey

other pseudomonad favored characteristics, the established importance of the oxidase test in characterizing pseudomonads cannot be ignored. These cultures thus remain unidentified.

DISCUSSION AND CONCLUSIONS

The data obtained in this study indicate a lower incidence of systemic bacterial infection than other surveys of healthy fishes. The data agree most closely with those of Bullock and Snieszko (1969) in which apparently healthy hatchery fishes were sampled and those of Bisset (1948) in which wild fishes were sampled, but are much lower than incidences found in other similar studies of hatchery and natural populations (Evelyn, 1960; Evelyn and McDermott, 1961; Rabb and McDermott, 1962; and Van der Struik, 1965).

Two common warmwater fish pathogens (*A. liquefaciens* and *P. fluorescens*) were expected to be encountered in this survey. These two species are commonly encountered in Southeastern U.S. fish kills and were reported in high incidence in surveys of Van der Struik (1965) and Bullock and Snieszko (1969). The *Pseudomonas* isolates reported here, however, did not produce fluorescence which is considered a characteristic for *P. fluorescens*. *A. liquefaciens* was isolated in relatively few instances (2.5%) when compared to the other published works.

The fact that no fungi were isolated was indicative that apparently healthy fish do not carry fungal infections in the kidney.

ACKNOWLEDGEMENTS

The authors wish to acknowledge their appreciation to Mr. Joe Addison and personnel of the Alabama Department of Conservation for aid in fish collection, Mr. John Plumb, Instructor, Auburn University, for helpful suggestions, and to Mrs. Pat Voorhees and Mrs. Phyllis Farthing for technical assistance.

LITERATURE CITED

- Bisset, K. A. 1948. Seasonal changes in the normal bacterial flora of fresh-water fish. *J. Hygiene* 46:94-97.
- Bullock, G. L. 1961. The identification and separation of *Aeromonas liquefaciens* from *Pseudomonas fluorescens* and related organisms occurring in diseased fish. *Appl. Microbiol.* 9:587-590.
- Bullock, G. L., and S. F. Snieszko. 1969. Bacteria in blood and kidney of apparently healthy hatchery trout. *Trans. Amer. Fish. Soc.* 98(2):268-271.
- Evelyn, T. P. T. 1960. The aerobic bacterial flora of certain Ontario fish. Masters thesis, Massey Library, Ontario Agricultural College, Guelph, Canada.
- Evelyn, T. P. T., and L. A. McDermott. 1961. Bacteriological studies of fresh-water fish. *Can. J. Microbiol.* 7:375-382.

Journal of the Alabama Academy of Science

- Hugh, R., and E. Leifson. 1953. The taxonomic significance of fermentative versus oxidative metabolism of carbohydrates by various Gram-negative bacteria. J. Bacteriol. 66:24-26.
- Kovacs, N. 1956. Identification of *Pseudomonas pyocyanea* by the oxidase reaction. Nature, Lond., 178:703.
- Novel, E. 1939. Une technique facile et rapide de mise en evidence cils bacteriens. Ann. Inst. Pasteur 63:302-311.
- Rabb, L., and L. A. McDermott. 1962. Bacterial disease of Ontario fresh-water fish. J. Fish. Res. Bd. Canada. 19(6):989-995.
- Van der Struik, A. 1965. Preliminary investigations in the occurrence of bacteria in fish stocks. European Island Fisheries Advisory Commission, Technical Paper, Rome, No. 2:21-34.

Clearcutting Silvicultural System

THE CLEARCUTTING SILVICULTURAL SYSTEM

L. E. DeBrunner

Department of Forestry

Auburn University, Auburn, Alabama

The objective of this paper is to provide clarification of technical concepts, terms, and procedures associated with forestry in general and with the clearcutting silvicultural system in particular. The paper is a defense of the clearcutting silvicultural system, which has received much criticism. No attempt is made to cover other silvicultural systems (seed tree, shelterwood, group selection, coppice, etc.) which may be alternatives.

Silviculture forms the core of forestry. It may be defined as the theory and practice of controlling forest establishment, composition, and growth. It must be made clear that this definition includes the process of harvesting the forest crop, the replacement of that crop with a new stand, and all other operations that keep a forest healthy, vigorous and productive.

The job of the forester involves consideration of the natural and economic factors coming to bear on the stands under his care, and the prescription and execution of the appropriate treatments *to achieve the management objectives*; this last mentioned item is the factor of predominant importance in this whole discussion. Management objectives are determined at some level higher than that at which the forester normally operates. In the case of a private company, they are determined by the board of directors, whereas in a public agency the head of the agency, the chief executive, or even the legislative branch sets the overall policy with regard to the objectives of management.

CONCEPT OF CLEARCUTTING

The definition of clearcutting, in the context of silviculture, is the complete removal of all trees, regardless of size, in the harvest operation. The term also implies that regeneration, i.e., establishment of a new stand, will be accomplished by some means following the harvest. Unfortunately, the term has been improperly applied, by both foresters and others, to almost any kind of harvest where all the merchantable trees (above a minimum size and quality) are cut, and the rest of the stand is simply left to occupy the site. *This is not biological or true clearcutting, but is a treatment called highgrading.* It is also referred to as *economic clearcutting*. On the surface, this may appeal to the average person, because some residual stems are left on the site and there is perhaps a more esthetically pleasing appearance than that of a totally prepared site, but the following point concerning quality must be remembered. When clearcutting does not remove the stand in its entirety, the residual stand will be made up of stems of poor vigor, form, and quality. Without the removal of the residual stand there would not be a new stand of thrifty, high quality trees.

Complete clearcutting can be applied to either even-aged or

many-aged stands which can be either merchantable or not merchantable. The new stand arising in its place will be even-aged unless, for some reason, some trees were left from the preceding stand. For example, trees might be left for mast production for wildlife, for den trees, or for land-line boundary trees (which should always be left). However, it must be stressed that any scattered trees like these are extremely vulnerable to lightning strike, windthrow, exposure, disease, and insect attack. Such dangers are very real, and frequently make it undesirable to leave residual trees unless they can be left in groups.

Complete clearcutting is most applicable in the case of species which normally occur in even-aged stands. It is applicable *only* to those species which can become established under conditions of full exposure. Some intolerant species (species which cannot withstand competition from larger trees) require the exposure inherent in the clearcutting method. Under virgin conditions, these species existed primarily because of catastrophic occurrences such as fire or windstorm (hurricanes or tornados). Other species cannot stand full exposure and must be handled in some other manner but, even so, the resulting stands may be essentially even-aged.

From a timber production point of view, clearcutting is unquestionably justified when mature or overmature stands are involved. This is particularly true when intolerant or relatively intolerant species are involved. Any cutting in such stands that leaves a portion of the stand in place makes that remnant highly vulnerable to disaster from insect and disease attack, excessive windthrow, sun scald, and other types of damage. It also is economically unsound to leave a portion of the stand, because the residual trees will not respond with increased growth as would those in a young vigorous stand after thinning.

Poorly stocked stands, or stands of questionable quality, usually are best handled by the use of complete clearcutting. In the case of a *wood producing operation*, there is no economic justification for growing less wood on a site than the site is capable of growing, nor is there any justification for growing larger defective trees or trees of the wrong species.

Any cutting system that leaves a portion of the merchantable timber standing on the logged area is usually more expensive than clearcutting, and therefore clearcutting can be justified from an economic point of view. The partial cutting systems are usually more expensive when the cost is calculated on a unit of wood basis because of need for tree marking by skilled technicians, the requirement for highly skilled (and highly paid) loggers, and lower production rates for the actual harvesting. In addition to these direct costs, damage to the residual stand (both root and trunk) is a cost that must be recognized.

REGENERATION

In clearcutting followed by natural regeneration, the establishment of the regeneration (seedlings) is dependent upon natural seeding of the harvested area. Three sources of seed are possible: (1) seed from

Clearcutting Silvicultural System

adjacent stands; (2) seed from the harvested trees, either still on the tree at harvesting or having been shed during the immediately preceding year; and (3) seed stored in the forest floor or "duff."

Seed from adjacent stands and seed from the stand cut (particularly seed shed during the preceding year) are by far the most common and important sources of regeneration. Use of seed stored in the duff layers of the forest floor for more than one year is limited to only a few commercial species, such as Atlantic white-cedar [*Chamaecyparis thyoides* (L.) B.S.P.] and yellow poplar (*Liriodendron tulipifera* L.). However, a large number of weed species, those with no commercial value, have seed stored this way.

The success of natural regeneration depends on a satisfactory seed supply distributed over the entire clearcut area, favorable weather conditions for germination and establishment, freedom from fire during the establishment period, and low incidence of insect and disease attack. Regeneration of a stand with desirable species using natural regeneration also requires the sudden and relatively complete exposure of the mineral soil. This may mean that supplementary site preparation (burning, disking, etc.) will be required. This is controlled primarily by the condition of the site with which the forester is dealing and the ecological characteristics of the species involved. In spite of the increased exposure, the moisture supply is usually increased since interception and transpiration losses are eliminated. Evaporation is increased, but not sufficiently to offset the gains. Runoff, of course, is increased. However, if the harvesting operation is carried out properly there usually is minimal erosion.

The advantages of clearcutting with natural regeneration revolve around the fact that all operations are concentrated in time and space. Operations are relatively simple and efficient. The cost of timber marking is minimized, because only the boundaries of the area to be cut need to be identified. The equipment and methods of harvesting are virtually unlimited, since there is no residual stand to protect and some soil disturbance is usually desirable for the establishment of the new stand. There are no trees left standing on the site to be destroyed by windthrow, lightning, or other agencies.

The outstanding disadvantage of clearcutting with natural regeneration is that the probability of obtaining an adequate stand of seedlings in a short time is quite low. It is like betting on a long shot, or like playing Russian Roulette with five chambers loaded and only one empty. The success of the regeneration process hinges on the timing of the harvesting operation to coincide with a good seed crop and the dispersal of that seed crop over a receptive seed bed. If the desired species does not become quickly established, undesirable vegetation is almost certain to take over the area. When this occurs the weed stand must be destroyed by some expensive site preparation procedure, and then the only practical thing to do is to establish the desired stand using some method of artificial regeneration. Not only are these additional operations expensive, but the time lost, time during which the new stand could have been growing, is truly an expensive item, especially

when short rotations¹ are used.

The problems associated with the rapid establishment of natural regeneration can be essentially eliminated by using the method of clearcutting with artificial regeneration. Complete clearcutting with artificial regeneration (usually planting) is the procedure over which there is currently much controversy. The most widespread application of the procedure is found here in the South, and involves our southern pines, primarily loblolly (*Pinus taeda* L.) and slash (*Pinus elliottii* Engelm.). As an indication of the magnitude of the operation, the Alabama Forestry Commission nurseries alone produced approximately 65 million seedlings for the 1970-71 planting season, which would be enough to plant about 118,000 acres. In addition to seedlings produced in the State-operated nurseries, a large number came from the one industrial nursery within the State, making the total number even larger. Up to June 30, 1970, a total of 1,988,363 acres had been planted in Alabama. In the 1969-70 planting season alone over 145,000 acres were planted in the State. This, of course, includes many acres of former agricultural land, but a majority has been cutover land, *clearcut land*.

The most common application of this silvicultural operation is in the form of forest management called "area regulation," or some modification thereof, where $1/R+1$ of the forest is cut each year. The "R" is the length of the rotation in years. The additional year is for the site preparation and planting phase. Therefore, if a 29-year rotation is planted, $1/30$ th of the forest is being harvested while another $1/30$ th is prepared and planted. This is the theoretical application. However, it rarely works out this neatly in practice. Site productivity differences, emergency wood cutting operations and other factors preclude such a simple procedure. As a result the percent of the area cut each year is subject to variation, but in most cases the entire area is cut over by the time rotation age is reached. A simple, but realistic, example would be to assume a 30,000 acre "working circle" with 30 one-thousand-acre compartments. One compartment would be cut each year while another is being prepared and planted. By the end of 30 years, every compartment in the working circle would have been treated and the cycle would be repeated.

The objectives of the method are: (1) to simplify forest administration and (2) to achieve efficiency with minimal cost in harvesting, site preparation, planting, and other silvicultural operations by treating large areas uniformly and at one time.

The climate, topography, soil, and species of the southern coastal plain are well suited to this practice. Repeating a point made earlier, the southern pines are relatively intolerant, and require drastic measures, catastrophic occurrence, for new stand establishment.

There has been abuse of the clearcutting and planting procedure. Planting is easy to prescribe. A species that appears to produce well

¹Rotation is the length of time in years from stand establishment to harvest.

Clearcutting Silvicultural System

can be planted just as easily as one that does not, even if it is planted off-site or outside its natural range. In the quest to achieve efficiency, foresters have been guilty of planting species off-site and have attempted to extend the range of certain species. In some cases the actions have been rather successful and the overall operation is simplified and the costs are minimized. Fortunately for foresters, most commercial tree species are relatively "forgiving." For example, slash pine appears to grow reasonably well when short rotations are used on many of the sites that formerly supported natural longleaf pine (*Pinus palustris* Mill.) in south Alabama.

However, there also have been some real fiascos! For example, absolute disaster, in the form of ice storm breakage, greeted the foresters' effort to move slash pine into the Sandhills of the Carolinas.

Monoculture threatens to be another "Pandora's Box." A great many foresters feel that it is not a good practice to have extensive stands of one species because of the dangers of massive insect or disease attack. However, as yet we in the South have not been hurt seriously because of such stand structure. The force of economics has made most industrial organizations accept this risk. They justify their actions on the premise that if large acreages of one species of southern pine are truly an invitation to total disaster, it should have been evident in the natural stands that existed prior to the initiation of American forestry practices. Perhaps there is some fallacy in this logic, but as yet there appears not to be.

The advantages of clearcutting with artificial regeneration are numerous and sometimes are of over-riding importance. It is relatively simple in application. When labor costs are high, it is the cheapest method that can be employed because it can be highly mechanized. It is the most certain method of obtaining rapid occupation of the site by the desired species in the desired amounts. It is the only method by which the land manager has real control over the level of stocking. It can be used when conversion of the stand from one species complex to another is necessary or desirable. Conversion can be accomplished quickly and positively in this manner. Finally, it is the only method applicable when seedlings from various tree improvement programs are to be introduced into the forest.

SITE PREPARATION

Traditionally, silviculturists have concentrated their efforts on the procedures and patterns through which the pre-existing stand is harvested and on the effect of removal on regeneration. This was primarily because the only site preparation that they could count on was that achieved during the harvesting operation. It was not until equipment became available for site preparation that intensive forestry began to appear on the American scene.

Site preparation, deliberate or accidental, probably is more important in the successful establishment of regeneration than is the method of cutting. Non-deliberate or incidental site preparation may

occur as a result of such operations as hazard reduction burning done prior to the harvest, or the harvest operation (logging) itself. Even wildfire may accomplish the site preparation objective, although it is not considered a desirable method. This unintentional site preparation may be sufficient to obtain acceptable regeneration, but it usually is not. The same logic basically applies in site preparation for forest crops as applies for agricultural crops; only the intensity of application differs.

Three major operations are recognized as components of site preparation: (1) logging slash disposal, (2) treatment of the forest floor and competing vegetation, and (3) treatment of the mineral soil. Of these, two are really pertinent to this discussion, slash disposal and the forest floor treatment. The treatment of the mineral soil involves fertilization, drainage, and irrigation. These are important considerations, but currently are not in widespread use.

Slash, the debris left after the logging operation, is unsightly and a potential wildfire bed; it impedes subsequent silvicultural operations; it may serve as a breeding place for certain insects and fungi which could attack the new stand; and, in many species, it tends to prevent seedling establishment and/or growth by simply being in the way. In the South, slash disposal takes the form of broadcast burning or piling the slash into long "windrows," which may or may not be burned.

Broadcast burning is simply the burning of slash where it lies. In the South, such burning usually is delayed until shortly before seeding or planting operations. It is used, not only to remove part of the debris left from logging, but also to eliminate the duff layer, to expose the mineral soil, and to kill back the sprouts of undesirable species and control grass and weed growth. When used in this manner, it also achieves the aims of seed or planting bed preparation. The only control operation carried out prior to the burning is the establishment of plowed or cleared lines around the area to be burned. This method of slash disposal is relatively cheap and can be used where regeneration is to be obtained from direct seeding, natural seeding, planting by hand, or planting with heavy machinery. Broadcast burning usually destroys only the lighter material. Consequently, light planting equipment cannot be used following slash disposal by broadcast burning because such equipment cannot safely climb over heavy debris, and a man riding an unprotected planting machine would be subjected to extreme danger.

In the South, piled or windrowed slash is frequently burned. Insofar as the regeneration operation is concerned, most of the benefits of the operation are derived from use of the machinery in the piling operation, and not from the burning. A bulldozer, with either a rake or a regular blade, scarifies the soil and thereby reduces competition. This is particularly beneficial where heavy brush might otherwise overwhelm the reproduction. The burning simply speeds up the breakdown of slash piles. Actually it would make little difference from a silvicultural point of view whether they were burned, except where the burning has the effect of reducing build-up of certain bark beetle

Clearcutting Silvicultural System

populations. In any case, the windrows would occupy area which could not be planted because burning rarely destroys heavy components of the debris.

In the South, treatment of the forest floor generally involves one or more of three major methods of site preparation. These methods are: (1) mechanical scarification, (2) use of fire, and (3) the application of herbicidal chemicals.

Included among the mechanical site preparation procedures are chaining (an operation in which the vegetation is knocked down and uprooted by a heavy anchor chain dragged over the area by two large tractors), disking, chopping, and bulldozing in all of its various forms. Other procedures exist but rarely are used. The most popular methods in the South are chopping and disking, which are both actually soil tilling procedures. In these processes, organic litter of the forest floor, along with logging debris, is mixed to some extent with the mineral soil. The procedures do not have the detrimental effect of concentrating the top soil in piles that so frequently accompanies bulldozing.

Disking usually is accomplished by using heavy disk harrows (10,000-20,000 lb classes). Chopping involves dragging a heavy rolling drum over the area. The drum is armed with steel blades. Either a single rolling drum (Fleico type, which weighs up to 25,000 lb) or a double drum (Marden type, which weighs up to 30,000 lb) can be used. The blades on these drums do the churning of the soil. Usually, the single drum chopper or, more recently, the LeTourneau Tree Crusher (a self propelled three drum chopper), is used first. This operation is followed by a double drum chopper treatment after the vegetation has had a chance to sprout. The last of these chopping operations should be carried out at least two months prior to planting.

These mechanical treatments accomplish several things. They redistribute the dead vegetation and tend to break it up. They disturb the root systems of brush and other competing vegetation, sometimes to the point that these are killed, but usually they are only prevented from completely taking over the site. These treatments also cultivate the soil so that the direct seeded or planted stock are more easily established.

Prescribed burning has many purposes, but the two of interest here are (1) seed and planting bed preparation and (2) hardwood control. Seed or planting bed preparation is quite similar in application to broadcast burning in slash disposal, and one fire may accomplish both objectives. Hardwood control is usually accomplished by burning prior to removal of the existing stand. A program usually begins five or more years before the removal cut and involves two or more burns. The first fire is a low intensity winter burn to reduce the quantity of fuel. One or more subsequent hot summer fires then are applied at one- or two-year intervals to reduce the hardwood stocking. The hardwoods are rarely if ever eliminated, but they are held in check so that the desired species can be established.

Use of herbicidal chemicals in site preparation is relatively new, and their history may be short. The introduction of chemicals came at a time when labor was becoming scarce and expensive and it appeared that the use of chemicals would offset the labor problem. However, concern over possible pollution and other detrimental effects has made chemicals much less attractive. It is doubtful that they will continue to be used where broadcast application is involved. Injection, the introduction of chemicals directly into the tree's cambium, may continue to be used, but labor scarcity and costs will make it less attractive.

Aerial spraying of silvicides has been used extensively in conjunction with fire and mechanical site preparation methods in order to gain better control of the site so that there is more assurance of success in the regeneration effort. When combined with fire, the chemical treatment precedes the burning by some four to six weeks. When used in conjunction with mechanical site preparation, the chemical application usually follows after six or more weeks. It is possible to combine all three site preparation methods in the prescription for a single area, although such intensity is rarely applied because of compounding costs.

ECONOMIC IMPLICATIONS

The large industrial forest landowners in the South, particularly those in the paper industry, have adopted the clearcutting system because of the advantages of the system. Clearcutting with artificial regeneration is a logical choice for these forest industries when one considers their management objectives. Within this context, clearcutting with artificial regeneration is a good system. The major objection that should be voiced is concern with how the method is used rather than with the system itself. The sizes of the individual clearcut areas often are too large. It is monotonous to drive for miles along certain highways in the South and see nothing but one massive clearcut area.

Why have foresters done this sort of thing? Most foresters do not see themselves as "insensitive timber beasts." They appreciate beauty as they see it. Yet, they have permitted these tremendous clearcuttings to take place. *Why?* The answer can be narrowed to a single point, the cost of practicing forestry, and in particular the cost of site preparation.

The clearcut area does not have to be large in order to harvest timber at a reasonable cost. Mechanized logging equipment that can harvest relatively small areas at a profit is available. Likewise, seeding or planting of relatively small areas can be accomplished without pushing the costs beyond reason. Virtually every operation necessary in the clearcutting silvicultural system can be applied on a smaller scale, with reasonable costs, *except* for the site preparation phase. In order to attain adequate site preparation, it is almost always necessary to use machinery of some sort. Furthermore, the machinery is large, heavy, and expensive to buy and to operate. This large equipment, to be

Clearcutting Silvicultural System

reasonably economical, must be used on large areas. It cannot be moved even a short distance without difficulty because tractors cannot be moved, along with drum choppers or disks, under their own power on roads. They must be dismantled and moved on trucks. Under ideal conditions 30 acres can be prepared per day per tractor. It takes most of a day, plus additional manpower and equipment, to move a tractor and its associated equipment to a new site, even if the distance is short. Moving from site to site is not productive, since the equipment is idle during this time. The ratio of idle time to productive time must be kept as low as possible or the costs of the operation become excessive on a unit area basis. Consequently it has been deemed necessary to have large areas treated so that excessive amounts of time are not lost in moving from site to site.

This is perhaps an oversimplification, but it is the major reason that the large 1,000-acre plus, clearcut areas exist. Why hasn't the problem been solved prior to the present? It is an engineering problem and engineers need to be involved in its solution. When they do become involved, perhaps the problem of mobility in site preparation equipment will be solved and extensive clearcut areas will not offend the eyes of the passerby.

PATTERNS OF RELIGIOUS AND POLITICAL INVOLVEMENT:
THEORETICAL IMPLICATIONS FROM MAX WEBER

Catherine T. Harris
Department of Sociology
Auburn University, Auburn, Alabama

At the present time, findings concerning the relationship between patterns of religious and political involvement have not been frequently reported within the context of a theoretical framework. As a result, the nature of the relationship between available empirical studies and theory in this area remains unclear. What appears to be needed is a theoretical framework, not only to form a basis for future empirical studies, but also to provide more meaningful interpretations of presently available findings. As a beginning step in this direction, an outline for such a theoretical framework will be suggested here. This theoretical framework will be based on principles appearing in Max Weber's *The Sociology of Religion*, clarified in terms of the conceptual frameworks of Robert Merton and Talcott Parsons.

In "The Protestant Ethic and the Spirit of Capitalism," Weber analyzes the role of religion as a possible independent variable influencing economic behavior. In *The Sociology of Religion*, especially in Weber's analysis of the relationship between religion and social stratification,¹ it becomes clear that religion may also act as a dependent variable. Weber describes how religious variation is patterned according to social class and special circumstances within each stratum. The network of interdependent variables that Weber describes will be used here to conceptualize a single multidimensional variable with structural and cognitive dimensions. The structural dimension will involve the individual's status ranking in terms of social class and the stability of his position in terms of status discrepancy. The cognitive dimension will include the individual's orientation to the value system and his perception of the relevancy of norms to his own situation. This multidimensional variable, which might be termed "integration into society," has to do with the degree an individual "fits" into society and his reaction to this "fit."

Although the focus of Weber's analysis is on religion, principles concerning the relationship between patterns of religious and political involvement are clearly implied. Two factors governing variation in religious orientation emerge: the nature of problems relating to the physical and social environment and the individual's available alternatives for dealing with these problems. These alternatives vary according to social class and the individual's relationship to the

¹R. H. Tawney, one of Weber's important "clarifiers," pointed out that Weber "did not profess to offer a complete interpretation even of the religious attitudes discussed in his articles; on the contrary, he urged the necessity of investigating how the attitude itself 'was in turn influenced in its development and character by the totality of social conditions, especially the economic ones.'" *Religion and the Rise of Capitalism* (New York: Penguin Books, Inc., 1947), p. 6.

political power structure. Religion potentially becomes a means to an end in two ways: it may provide a potential means of coping with problems (in terms of solutions and adjustments) and/or it may serve to legitimate a means of coping already adopted. Thus, according to Weber, the individual's orientation to religion will be consistent with his total life style, reflecting his available alternatives for dealing with the problems related to his physical and social environment.²

Weber sees Christianity as an urban religion³ which, in its Protestant form, tends to emphasize a rational-ethical view of the world. The religion of the middle classes and what Weber terms the "bureaucratic classes" is consistent with the rational-ethical values around which an urbanized commercial society is organized.⁴ Those seeking privilege within such a framework support religions that are consistent with their life positions, making their striving legitimate.⁵

Weber compares the religion of the privileged classes with the religion of the nonprivileged classes, describing a pattern of variation. The privileged classes require of religion only the reassurance of legitimacy if anything at all. Through religion, the disprivileged classes replace what they cannot be now with what they will become.⁶ Weber argues that "the lower the social class, the more radical are the forms assumed by the need for a savior, once this need has emerged."⁷ In the pattern that Weber describes, the type of religion associated with each social class is consistent with the problems and alternatives at that level. Thus religion may legitimate striving or it may serve as a means of adjustment to the absence of alternatives, replacing what cannot be with what will be. Weber views two forms of religion as adjusive: magical and soteriological.⁸

According to Weber, religion is not only patterned according to social class, but is patterned according to special circumstances within each class. One circumstance that he describes has to do with what today is termed "status discrepancy." Persons who are in economically unstable strata and in danger of downward mobility are readily susceptible to being influenced by "missionary enterprise" that has a distinctive

²Max Weber, *The Sociology of Religion*, trans. Ephriam Fischhoff (Boston: Beacon Press, 1964), pp. 60-206.

³*Ibid.*, p. 84.

⁴*Ibid.*, pp. 91-97.

⁵*Ibid.*, p. 107.

⁶*Ibid.*, p. 106.

⁷*Ibid.*, p. 102.

⁸*Ibid.*, pp. 101-108.

magical or soteriological quality.⁹ Here is another example of religion as a perceived means of coping that serves an adjustive function.

Perhaps the deeper implications of Weber's analysis would become apparent if clarified by utilizing the conceptual systems of Robert Merton and Talcott Parsons. A contemporary functionalist, Robert Merton has analyzed deviant behavior in American society in terms of a malintegration between cultural goals and institutionalized means to achieve these goals. According to Merton's well known argument, the dominant cultural goal is success, defined in terms of the accumulation of money. Cultural goals are emphasized while institutionalized means to achieve these goals are deemphasized. Further, the available means to attain goals are unevenly distributed throughout society creating what he calls a "strain toward anomie,"¹⁰ or breakdown of the normative structure. He describes five culturally patterned alternatives for adjusting to this malintegration. These forms of adjustment range from conformity, or acceptance of both the cultural goals and institutionalized means, to rebellion, a transitional response which seeks to institutionalize new goals and/or means.¹¹

Assuming that traditional organized religion in the United States presents values that are consistent with the dominant value system¹² and expressing Weber's principles in Merton's terms, several principles follow. Religion may be associated with the normative structure and, as such, may become a part of the network of institutionalized means for goal attainment through legitimation and definition of norms. In American society, for example, some forms of traditional organized religion could be an activity of strivers who accept the legitimacy of cultural goals and define traditional religion as consistent with those goals and perhaps also the institutionalized means, illustrating Merton's "conformity." Other forms of traditional organized religion may serve to create a community for those who have chosen to deemphasize the success goal and emphasize the institutionalized means, illustrating the form of adjustment Merton calls "ritualism." To those for whom the normative structure seems least relevant and/or even illegitimate, Merton's "rebellion" is a probable response. Thus, pressure to change either the goals or the normative structure could come from those who have attained success and rejected it or those who have been unable to

⁹*Ibid.*, p. 101. According to Weber, these strata include the lowest and most economically unstable proletariat and the "proletaroid or permanently impoverished lower middle class groups who are in constant danger of sinking into the proletarian class."

¹⁰The literature relevant to the concept "anomie" is too extensive to be discussed here.

¹¹Robert K. Merton, "Social Structure and Anomie," *American Sociological Review*, III (October, 1938), 672-682.

¹²A number of sociologists have argued along this line. For a summary of the literature in this area, see N. J. Demerath and P. E. Hammond, *Religion in Social Context* (New York:Random House, 1969), pp. 202-212.

attain it: members of the highest and lowest social classes and perhaps intellectuals.¹³ These groups might be more likely to become involved in social movements committed to changing the dominant value system or normative structure in some way and less likely to be involved in traditional organized religion. Merton's other forms of adjustment, "innovation" and "retreatism," are likely to express themselves in other terms than the development of traditional religious forms, since they both involve a rejection of means that may be legitimated by religion.

Weber's framework for explaining religious variation, as it relates to values, involves much more than a description of dominant value orientations.¹⁴ What is required here, in order to clarify some of the deeper implications of Weber's analysis, is a conceptual scheme that will describe not so much dominant values, but orientation to values and the value system. An individual's orientation to the value system could be viewed as an indicator of what might be termed an individual's "integration into society."

Perhaps an effective means to discuss value orientation in this connection is in terms of Talcott Parson's pattern variables, especially universalism and particularism.¹⁵ Assuming that in American society, universalism is dominant,¹⁶ a particularistic value orientation might be an indication of low integration into society. A universalistic value orientation, on the other hand, might indicate an acceptance of the legitimacy of dominant values, reflecting a higher degree of integration into society. Value orientation as well as social class is included in the network of variables that influence patterns of religious and political involvement.

Although Weber argues that the religious orientation that has come

¹³According to Weber, "only those anti-religious sects which are able, at least temporarily, to carry a quasi-religious belief in the socialist eschatology exercised control over a stratum of declassed intellectuals." *op. cit.*, p. 135.

¹⁴Although it is clear that Weber suggests a pattern of relationship between societal types (in terms of dominant values) and forms of religion, this issue is not of immediate interest here.

¹⁵Talcott Parsons and Edward Shils (eds.), *Toward a General Theory of Action* (New York and Evanston: Harper and Row, 1951), pp. 80-88. According to Parsons, the pattern variables describe dominant value orientations as well as normative expectations. The other pattern variables may also be relevant but this analysis will focus on universalism and particularism.

¹⁶Talcott Parsons has argued that "there is a fundamental strain of universalistic individualism in Christianity" and this has contributed to "the egalitarian strain of modern Western civilization." "Religion as a Source of Creative Innovation," *Religion, Society and the Individual*, J. Milton Yinger (Toronto: The Macmillan Company, 1957), Part II, 562.

to be called sectarian is frequently found in the lower classes, he points out that there is a distinctive religion of the lower classes only in a limited sense.¹⁷ The foci of religion of the lower classes reflect the adjustive role of religion; the form depending on the problems and alternatives for problem solving available.¹⁸

The church-sect typology, originally formulated by Ernst Troeltsch, based on the work of Weber, seems to be the best available description of the pattern of differences that Weber describes. Goldschmidt has observed that the church-sect typology revolves around two major axes of differences: internal organization and attitudes toward the secular world.¹⁹ In the original formulation, the *ecclesia*, or the state church, actually sought to be a power within the world. Later formulations have omitted this characteristic, since the typology has been used for analysis in American society within which there is no state church. The *ecclesia*, however, is associated with dominant values of the society, even though it may not actually be a part of the power structure. Benton Johnson has recently argued that there is really only one variable involved in the church-sect typology; acceptance or rejection of the world.²⁰ Russell Dynes, testing the relationship between hypothetical religious preference in church-sect terms and social class, found that the lower class pattern was sectlike, while the upper class pattern was churchlike.²¹

Weber viewed social class as only one of a network of variables important in determining religious orientation. Many of these variables are involved in the individual's orientation to the dominant value

¹⁷Weber, *op. cit.*, p. 101.

¹⁸Weber, *op. cit.*, pp. 95-117.

¹⁹Walter R. Goldschmidt, "Class Denominationalism in Rural California Churches," *American Journal of Sociology*, XLIX (1944), 348-355, cited by N. J. Demerath III, *Social Class and American Protestantism* (Chicago: Rand McNally and Company, 1965), p. 41.

²⁰Benton Johnson, "On Church and Sect," *American Sociological Review*, XXVIII (August, 1963), 539-549.

²¹Russell Dynes, "Church-Sect Typology and Socio-Economic Status," *American Sociological Review*, XX (October, 1955), 555-560. A large number of studies since World War II have made a case for high status religiosity based on such indicators as church membership, church attendance and participation in the formal activities of the church. It has been argued that these studies assume that religion has only one dimension. Charles Glock and others have attempted to describe the different dimensions of religiosity and relate these dimensions to social class. For a discussion of this line of research, see N. J. Demerath III, *Social Class and American Protestantism*. For the original formulation of the church-sect typology, see Ernst Troeltsch, *The Social Teachings of the Christian Church*, trans. Olive Wyon (New York: The Macmillan Company, 1932).

system. For example, Weber observes that in a society in which rational-ethical values are dominant, those who are able to deal with life problems in terms of rational-ethical values, often hold religious orientations incorporative of these values.²² Conceptualizing Weber's idea in Parson's terms, those who are effective within a system of values that have universalistic or generalized application would support the system's values. Those who are effective within a system of rational-ethical values that have universalistic application would support the legitimacy of rational-ethical values. Those who are not effective within such a system may support alternative values. Since organized religion may become associated with the power structure, the same factors that influence religious orientation will necessarily influence attitudes toward the political order. Religion may tend to be supportive of the values around which goal attainment norms are organized. Those who have rejected these values, or found these goal attainment norms ineffective for them, may reject traditional organized religion in all its forms and become committed to alternative values or committed to the establishment of alternative values and norms in society. This response could take a number of forms, including involvement with political movements and "radical politics," committed to major changes in the existing social structure.

In society with a universalistic value orientation, those who are not well integrated into society and those for whom some of the values are not meaningful may develop particularistic normative expectations.²³ This may not imply a rejection of the legitimacy of the values at all, but a "bending" of the values to fit special circumstances. This response, while involving a low degree of integration into society, involves a greater degree of integration into society than the rejection of dominant values. In such a case, it may be that particularistic ties will be emphasized. Sect type religion with its rejection of the secular world and its emphasis on the sect as a fraternalistic moral community would reflect this, and may well represent a type of adjustment within the social structure, where its forms represent a variety of religion that is consistent with the dominant values. As such it may represent a form of ritualism (emphasizing the means, deemphasizing the goal) that may possibly serve as a mechanism to integrate its members into society. For example, Benton Johnson reported that Holiness sects socialize their members in dominant values, actually helping them to become upwardly mobile.²⁴

Assuming a society within which the values of traditional organized religions are consistent with dominant values, the rejection of organ-

²²Weber, *op. cit.*, p. 97.

²³According to Parsons, particularistic normative expectations occur where the situation is defined in terms of the characteristics of the persons involved and not generalized. Parsons and Shils, *op. cit.*

²⁴Benton Johnson, "Do Holiness Sects Socialize in Dominant Values," *Social Forces*, XXXIX (May, 1961), 309-316.

ized religion may indicate a greater degree of alienation from society's dominant values than the sectlike religious orientation. The groups that Weber describes as indifferent to religion are those who either do not need religion or regard it as a means (the classless intellectuals, the stable affluent) or those for whom religion is not utilized as an effective means of coping. For example, Weber talks about the indifference of the proletariat to rational-ethical religions of the modern bourgeoisie. Religion, in the traditional sense is supplanted by other ideological surrogates, reflecting the fact that "a sense of dependence on ones own achievements is supplanted by a consciousness of purely societal factors, economic conjectures, and power relationships guaranteed by law."²⁵

A number of empirical studies dealing with some of the separate dimensions of integration into society, as it is in the process of being conceptualized here, have appeared although many have been related to either religious involvement or political behavior and not both. One notable exception to this is a study done by Gary T. Marx, who, in an analysis of religiosity and protest, found for a nationwide sample of Negroes that the greater the religious involvement the less militancy in civil rights.²⁶ Findings of this type cannot be regarded as conclusive, however, since there is disagreement concerning what constitutes a proper measure of religiosity. Thus, Marx has also reported that civil rights militancy increases with social class, lending credibility to the notion that upper status persons are more likely to become involved in "radical" social movements.²⁷ In this same connection, Kenneth Kenniston has reported that members of the "new left" among college students are more likely to be from a higher social class than other students; moreover, they are likely to be students who make relatively high grades.²⁸

Rodney Stark found religious apathy in the lower class in Great Britain. He reports that dissatisfactions resulting from status deprivation implies a lessening of religious involvement and a greater involvement with "radical" politics. He argues that religion and radical politics may both function in this manner, although he offers no explanation regarding why one response may occur rather than another.²⁹ On the basis of data gathered in France, the Netherlands, the United States

²⁵Weber, *op. cit.*, p. 100.

²⁶Gary T. Marx, "Religion: Opiate or Inspiration of Civil Rights Militancy," *American Sociological Review*, XXXII (February, 1967), 698-706.

²⁷Gary T. Marx, *Protest and Prejudice* (New York: Harper Torchbooks, 1967), p. 63. See also pp. 49-79.

²⁸Kenneth Kenniston, "The Source of Student Dissent," *Journal of Social Issues*, XXIII (1967), 108-137.

²⁹Rodney Stark, "Class Radicalism and Religious Involvement," *American Sociological Review*, XXIX (October, 1964), 298-706.

and Colombia, Glock and Stark found support for the hypothesis that "to the degree a man was committed to revisions in status arrangements in his society, he would be likely to have turned from religious institutions."³⁰ Support is also reported for the hypothesis that "the greater the left-right dispersion within a political system, the greater the difference in religious involvement between the most extreme parties," as well as the prediction that those supporting parties on the left would be less involved in religion than those supporting parties on the right.³¹

Studies involving an analysis of a relationship between status discrepancy and political behavior have yielded conflicting results. Some studies have indicated a relationship between status discrepancy and "right wing extremism,"³² while others have demonstrated a relationship between status discrepancy and political "liberalism."³³ Still others have indicated that there is no relationship between these two variables.³⁴ The inconsistency of these findings may be explained in part by the methodological difficulties in developing a measure of status discrepancy. Although N. J. Demerath III has reported that highly discrepant Protestants are more involved in sectlike religion, he was critical of the methodology behind these findings.³⁵

(There have been suggestions that a relationship between anomie and religious and political involvement should be analyzed, although little information has been gathered in this area. Thomas O'Dea has argued that sectlike religiosity serves as an escape from anomie.³⁶)

It would seem then, on the basis of Weber's analysis, clarified through the use of the conceptual systems of Parsons and Merton, and on the basis of available evidence, that a network of interdependent variables influences the development of certain patterns of religious

³⁰Charles Y. Glock and Rodney Stark, *Religion and Society in Tension* (Chicago: Rand McNally and Company, 1965), p. 224.

³¹*Ibid.* See especially pp. 190-226.

³²For example, see Gary B. Rush, "Status Consistency and Right Wing Extremism," *American Sociological Review*, XXXII (February, 1967), 86-92.

³³For example, see Gerhard Lenski, "Status Crystallization: A Nonvertical Dimension of Social Status," *American Sociological Review*, XIX (August, 1954), 405-413.

³⁴For example, see William F. Kenkel, "The Relationship between Status Consistency and Political and Economic Attitudes," *American Sociological Review*, XXI (June, 1956), 365-368.

³⁵Demerath, *Social Class and American Protestantism*, pp. 127-173.

³⁶Thomas O'Dea, *Sociology and the Study of Religion* (New York: Basic Books, 1970), pp. 190-197.

and political involvement. Following Weber, these principles have been expressed as a multidimensional independent variable, termed "integration into society." Integration into society has been conceptualized in terms of a cognitive dimension, including the individual's orientation to the value system and his perception of the relevancy of the norms to his own situation, and a structural dimension, which involves the individual's status ranking as well as the stability of his position. This multidimensional variable has to do with the degree an individual "fits" into society and his reaction to this "fit." The following hypotheses summarize the suggested relationships between integration into society and certain patterns of religious and political involvement:

- Hypothesis I The highest and lowest degrees of integration will be related to an indifference to traditional organized religion.
- Hypothesis II The highest and lowest degrees of integration will be related to an involvement with "radical" politics.
- Hypothesis III In the middle ranges of the continuum of integration-nonintegration, some degree of involvement with traditional organized religion will be present.
- Hypothesis IV In the middle ranges of the continuum of integration-nonintegration, the more integrated will have a churchlike religious preference. The less integrated will have a sectlike religious preference.
- Hypothesis V In the middle ranges of the continuum of integration-nonintegration, the more integrated will be oriented to "liberal politics." The less integrated will be oriented to "conservative politics."

At the present time, a first test of these hypotheses is being carried out.

Cosmic X-Ray Observations

A SUMMARY OF RECENT COSMIC X-RAY OBSERVATIONS

Robert M. Wilson
Space Sciences Laboratory
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

INTRODUCTION

In a previous paper [1], the general features and characteristics of cosmic X-ray emitters were described, their early observations and descriptive data were summarized, their distribution discussed, and the five most studied X-ray objects were examined. Also included was a brief discussion of the immediate future of X-ray astronomy, in which specific needs and planned programs were stressed.

This paper updates and complements the aforementioned paper. A general background review is followed by condensed descriptions of several major topics of interest in current cosmic X-ray astronomy studies. This paper is concluded with a discussion of immediate and long-term needs of cosmic X-ray astronomy.

BACKGROUND REVIEW

The discipline of cosmic X-ray astronomy had its earliest beginnings in June 1962 when Giacconi et al. [2] discovered a source of X-ray emission in the 0.2- to 0.8-nm (2- to 8- \AA) range originating outside the solar system. The X rays appeared to emanate from a region near the galactic center, more specifically in the direction of the constellation Scorpius. A general isotropic background of X rays was also revealed. Further observations confirmed the initial discovery of cosmic X rays and also revealed more X-ray sources. The first discovered X-ray source is now known as Scorpius X-1 or Sco X-1, meaning the first-discovered X-ray emitter in the constellation Scorpius.

Theoretically [3], the answers to many of the most fundamental astrophysical problems of stellar evolution, the origin of cosmic rays, and the large scale structure of the universe are linked with the emission of X rays and gamma rays. Therefore, observation of these high energy rays would be helpful in understanding these problems.

Some 60 X-ray sources have thus far been resolved against a diffuse, nearly isotropic background radiation [1, 4-7]. The strongest source is about 2000 times as bright as the weakest source detectable with present instruments. Nearly all the sources lie close to the galactic plane and most likely are members of the spiral arms of the Milky Way. Variability is a common feature. Flare-like outbursts up to 4 times the normal brightness and lasting some 10's of minutes have been observed. At least three sources — Cyg X-2, Cen X-2, and Cen X-4 — have appeared suddenly, risen to maximum brightness, and decayed with time in a manner similar to the behavior of novae. The X-ray powers in the 1.60210×10^{-16} -J to 1.60210×10^{-15} -J (1- to 10-keV)

range are typically about 10^{29}W (10^{36} ergs per second), 1000 times the total luminosity of the Sun, and Sco X-1, one of the optically identified sources, is 1000 times as bright in X rays as in visible light. Another optically identified source, designated Virgo X-1, is identifiable with a distant radio galaxy Virgo A (M87), and its X-ray luminosity is 70 times its radio power. A few of the sources have been identified with optical counterparts; still others have only possible optical identifications.

Two sources, Tau X-1 and Sco X-1, have been studied most intensively. Tau X-1 has been identified with an extended region in the Crab Nebula [8,9] about 2 light years in diameter, and it contains a pulsar (NP 0532) at its center [10-13]. The pulsar has been observed in the radio, visible, and X-ray spectrum at a frequency of 30 pulses per second. It has an extended spectrum which approximately matches a power law to $8.010 \times 10^{-14}\text{J}$ (500 keV) and is perhaps the most luminous galactic X-ray source ($\sim 10^{30}\text{W}$) ($\sim 10^{37}$ ergs per second).

On the other hand, Sco X-1 [14] has been identified with a 12th to 13th magnitude, blue starlike object. Its X-ray spectrum fits a thermal bremsstrahlung model at a temperature of about 50 million degrees Kelvin in the 0.1- to 1.0-nm (1- to 10^{-8}\AA) range. It may be an order of magnitude less luminous than Tau X-1 ($\sim 5 \times 10^{29}\text{W}$) ($\sim 5 \times 10^{36}$ ergs per second) and is barely detectable at radio wavelengths.

Various models [15-20] have been proposed to explain the existence of cosmic X-ray sources. Among the most popular are the supernova remnant in which the formation of a neutron star results, and the close binary model in which a white dwarf or neutron star accretes mass from its companion star. Tau X-1 seems to fit the first type while Sco X-1 seems to be a member of the second group. Therefore, Tau X-1 and Sco X-1 are looked upon as prototype X-ray sources of two distinct classes of X-ray objects.

This simple "two-class" approach to X-ray source classification has been compounded by the recent discovery of flaring sources [21-24] and of extragalactic X-ray emitters, such as normal galaxies [25], radio galaxies [26-27], QSO's [28-30], and possibly Seyfert galaxies [31]. Therefore, a larger, more definitive classification scheme has come into being, such as the one seen below.

Classification of X-ray sources:

- Blue starlike objects (Sco X-1, Cyg X-2)
- Flaring sources (Cyg X-1, Cen X-2, Cen X-4)
- Supernova remnants (Tau X-1, NP 0532)
- Normal galaxies (LMC)
- Radio galaxies (M-87)
- QSO's (3C 273)

Seyfert galaxies

Much of the current endeavor in cosmic X-ray observations remains in the area of source parameter determination; that is, acquiring the number and position of all X-ray sources over the celestial sky, as well as their angular sizes; determining X-ray spectra over some wavelength or energy band; obtaining flux or intensity measurements over that spectral band; and remarking somewhat on the source type, mechanism, model, etc. Increased technology and spatial and spectral knowledge have resulted. Some of these recent studies have also been concerned with the correlation or simultaneous observation of optical and X-ray data from optically identified X-ray sources, such as Sco X-1. Other major efforts include polarization and emission-line structure investigations, which are concerned with the determination of the nature of the source mechanism and the source model. NP 0532, the Crab Pulsar, continues to intrigue radio, optical and high energy astronomers with its highly accurate double-pulsed signal structure; and of course, the spectrum and the origin of the diffuse background radiation is still highly debatable. Summarized descriptions of these current research areas follow.

SIMULTANEOUS OPTICAL AND X-RAY OBSERVATIONS OF SCO X-1

One of the important questions in cosmic X-ray astronomy is whether the optical and X-ray fluxes from Sco X-1, or any other optically identified source, are coupled. To ascertain this relation, simultaneous observations of the optical and X-ray signals have been performed by a number of observers [32-37]. The general consensus is that Sco X-1 does indeed exhibit optical and X-ray correlation, especially during times of optical and X-ray flaring as observed by OSO-III [35]. A plasma model — that is, thin-source, thermal bremsstrahlung — has been developed to interpret these observations and it should be noted that the data support such a model. It has also been found that the total X-ray flux is greatest when the object is brightest. The small discrepancy which exists between optical observations and thermal-bremsstrahlung prediction is accounted for by self-absorption within the source and interstellar extinction.

Figure 1 summarizes some of the results described in the previous paragraph concerning the correlation of optical and X-ray data from Sco X-1. Part (a) shows the optical intensity of Sco X-1 in blue light (B mag) versus time for the rocket flight [36]. Notice the variability of the source. Notice also that the time of X-ray observation came when Sco X-1 was fairly faint. It should be remembered that the source is brighter when the magnitude number is more negative, and the source is fainter when the magnitude is more positive. Part (b) depicts the optical and X-ray spectrum of Sco X-1 as fit by a thermal-bremsstrahlung spectrum with a temperature of $1.121470 \times 10^{-15} \text{ J}$ (7 keV). Self-absorption within the source and interstellar extinction can account for the optical intensity being less than the bremsstrahlung prediction. The total X-ray energy flux above $1.60210 \times 10^{-16} \text{ J}$ (1 keV) versus B mag of Sco X-1 is shown in part (c). This curve demonstrates the belief that the total energy in the X-ray region is greatest when the object is brightest.

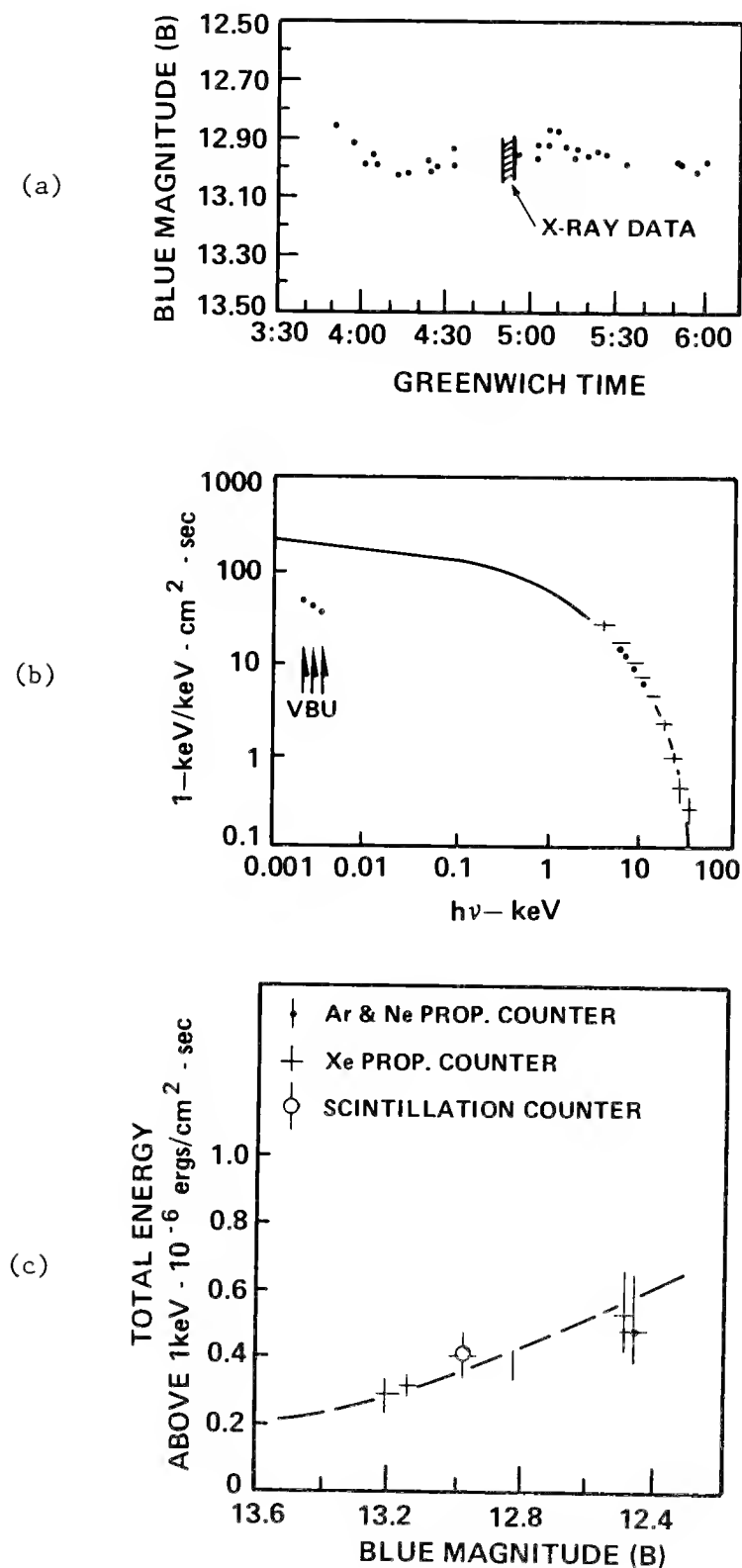


FIGURE 1. (a) Optical intensity in B versus time (Sco X-1); (b) Optical and X-ray spectra of Sco X-1; (c) Total X-ray energy above 1 keV versus B-mag (Soc X-1).

Cosmic X-Ray Observations

In summary, Sco X-1 does seem to show general correlation between its optical and X-ray data, especially when flaring. However, more simultaneous measurements are required to determine the validity of the model of Sco X-1 and to resolve the ultimate question of correlation.

POLARIZATION

A group at Columbia University continues to study the X-ray polarization of various sources and the diffuse background [38-40]. Their basic instrument has been a soft X-ray polarimeter utilizing Thomson scattering. Thus far, no firm evidence to support the theory of polarization of the X rays from Sco X-1, Tau X-1, or for a spurious instrumental polarization from the cosmic-ray background, has been found.

The interest in cosmic X-ray polarization is stimulated by the hope of obtaining information about source mechanisms. Polarization could be expected if the emission process were synchrotron radiation. The fact that Sco X-1 shows spectral characteristics similar to those of old novae, the absence of appreciable polarization in the visible spectrum, and the exponential form of the X-ray spectrum are generally taken as evidence that the X rays are produced by thermal bremsstrahlung and not by synchrotron emission. However, it has recently been shown that, even with a thermal-bremsstrahlung model [39], one might expect polarization of a few percent if the source is not spherically symmetric and if the electron density is great enough to give a high probability for electron scattering. Finally, it is important to note that both optical and X-ray flares have been observed in Sco X-1 and that these might be polarized.

The observed spectrum and polarization of the optical and radio radiation from the Crab Nebula are generally accepted as synchrotron emission. The X-ray flux, first observed in 1963 [8], originates in the central portion of the nebula and is coincident with the region of highest luminosity and polarization. The X-ray spectrum appears to be a natural extension of the optical synchrotron radiation, in which case the X-ray and optical radiation would have comparable polarization. Serious questions have been raised regarding the source and lifetimes of relativistic electrons energetic enough to emit synchrotron radiation at X-ray wavelengths, so, in 1967, Sartori and Morrison [16] proposed a hot-plasma model as an alternative X-ray production mechanism. The measurements of the spectral behavior of the X-ray flux cannot be used to distinguish between the two models, but a measurement of the X-ray polarization with a positive result would clearly provide unambiguous evidence for the synchrotron process. A negative result could indicate either a nonsynchrotron process or synchrotron emission in a region of highly disorganized fields.

Precise polarization measurements of the X-ray radiation of Tau X-1, as well as all the bright X-ray sources, would serve to distinguish between the possible production processes. Comparable X-ray and optical polarization would be quite compelling evidence for synchrotron X-ray radiation. Hopefully then, new data will become available to clarify the production mechanism question.

EMISSION-LINE STRUCTURE

Related to the production mechanism question is the study of emission-line structure. It also can indicate to some degree the source mechanism or mechanisms and source structure. Models have been constructed by Tucker [41] and Tucker and Gould [42] based on elemental-abundance distribution for thermal X-ray sources. The models are based upon radiation from an optically thin plasma at a temperature in excess of 1 million degrees Kelvin. Other thermal models, especially those of Sartori and Morrison [16], have also been developed and have been found to predict an iron-line component of the spectrum. Recent observation [43-46] of Sco X-1 and Tau X-1 to verify this iron-line emission at about $9.61260 \times 10^{-16} \text{J}$ to $1.121470 \times 10^{-15} \text{J}$ (6 to 7 keV) ($\sim 1.9 \text{ \AA}$) have thus far been unsuccessful, although the data do indicate a substantial flux excess at this particular photon energy level, consistent with theory.

Although evidency which suggests iron-line emission in the X-ray spectrum has increased, truly conclusive evidence for the presence of this line emission remains lacking. It is hoped that larger detectors with longer integration times can be flown (possibly aboard satellites) to resolve this question. Then, an answer to the source model and mechanism, and, therefore, physical processes and source structure, will be clearly determined.

NP 0532, THE CRAB PULSAR

The discovery of radio pulsars came as an accidental by-product of experiments to study the interplanetary scintillation phenomenon of quasar radiation that passed through the extended solar corona [47-49]. These unusual objects are of major interest not only to radio and optical astronomers, but also to the X-ray community as well. Since the initial discovery of pulsars in 1967 [47], much work has been done to catalog the source positions precisely, to determine the pulsed-signal rates accurately, and to develop adequate theoretical models to explain the pulsed-signal mechanisms responsible for the pulsar intensity. The clock-like regularity can be attributed only to an oscillating or rotating star of very small dimensions or to orbital motions. With some 60 pulsars thus far discovered, the periods range from 33 ms to 3.7 seconds.

Within one year after the discovery of pulsars, a pulsar was discovered within the Crab Nebula and designated NP 0532 [7, 10]. The data are best understood by assuming the pulsar to be a rapidly rotating neutron star. X-ray astronomers have shown that approximately 5 percent of the X rays from the Crab are pulsed in synchronism with the light in the X-ray spectrum rather than in the visible spectrum. The combined X-ray, radio, and optical observations all support the model of the Crab Nebula being energized by a rotating neutron star.

Today the Crab is observed as a whitish amorphous mass enmeshed in tangled filaments of red, glowing hydrogen [5, 49]. Because the white light continuum and the radio emission are highly polarized, it

Cosmic X-Ray Observations

was recognized that the radiation is synchrotron emission. While all the evidence strongly suggests that the synchrotron process is responsible for the entire spectrum from radio to X rays, a fundamental problem exists in accounting for the lifetime of the responsible electrons. In the process of producing synchrotron radiation, electron energy is depleted. Thus, a continuing source of energy capable of accelerating electrons to relativistic energies on a very short time scale (<1 year) is required.

Consequently, considerable speculation that the radiating object which would energize the Nebula might be a neutron star remnant of the supernova explosion was expressed. At a surface temperature as high as 10 million degrees Kelvin, a neutron star would radiate like a blackbody with a peak in the neighborhood of several nanometers (a few angstroms). Shortly after the discovery of the radio pulsar NP 0532 in the Crab [10], the central star of the Nebula was found to flash visibly [11, 12], as in the X-ray [13] and infrared regions, at the same radio pulse rate. Within a month of the discovery of the Crab pulsar, it was found that its periodicity was increasing at the rate of one part in 2400 per year. The optical counterpart of the radio pulsar, when photographed under normal conditions appeared to be an innocuous star of 18th magnitude. Viewed with stroboscopic image-amplifier techniques, it was found to flash to 15th magnitude 30 times per second. In the X-ray spectrum the flashes carry a power 100 times as great as the optical luminosity and 10,000 times as great as the radio power. The total pulsed output is enormous, about 10^{26} kilowatts — 1000 times the full steady power of the Sun over all wavelengths.

The radio, optical, and X-ray spectrum of Tau X-1 and the Crab pulsar NP 0532 is clearly seen in Figure 2 [49]. The log of the flux is plotted against the log of the electromagnetic frequency. The plots note spectra indices of negative slopes corresponding to synchrotron power laws. "A" represents a very bright, compact, low frequency radio source discovered during the July 7, 1964, lunar occultation, and probably is associated with the radio pulsar designated "B." Solid lines represent the spectrum of the Crab as a whole; dashed lines show pulsar observations in the infrared, optical, soft X-ray and hard X-ray regions. The pulsed radiation from the Crab has a double-pulse profile which appears in all ranges of the spectrum from radio waves to X rays. Although the main pulse and interpulse peaks appear simultaneously to within a millisecond, the shapes of the X-ray and optical pulses are markedly different. Furthermore, the ratio of continuous X-ray ($1.60210 \times 10^{-16} \text{ J} - 1.60210 \times 10^{-15} \text{ J}$) (1-10 keV) to visible light emission is only a factor of 2, but the pulsed ratio is about 100. With increasing energy of X rays, the ratio to continuous radiation appears to increase rapidly — from 5 percent in the 1.281680×10^{-16} to $6.40840 \times 10^{-16} \text{ J}$ (0.8- to 4-keV) range to 17 ± 5 percent from in the 4.005250×10^{-15} to $1.60210 \times 10^{-14} \text{ J}$ (25- to 100-keV) range.

Much work remains to be accomplished concerning pulsar activity in stellar X-ray astronomy. X-ray periodicities need to be searched for over various period ranges, as well as at all wavelengths. Correlation between the pulses should be investigated. Also, the main

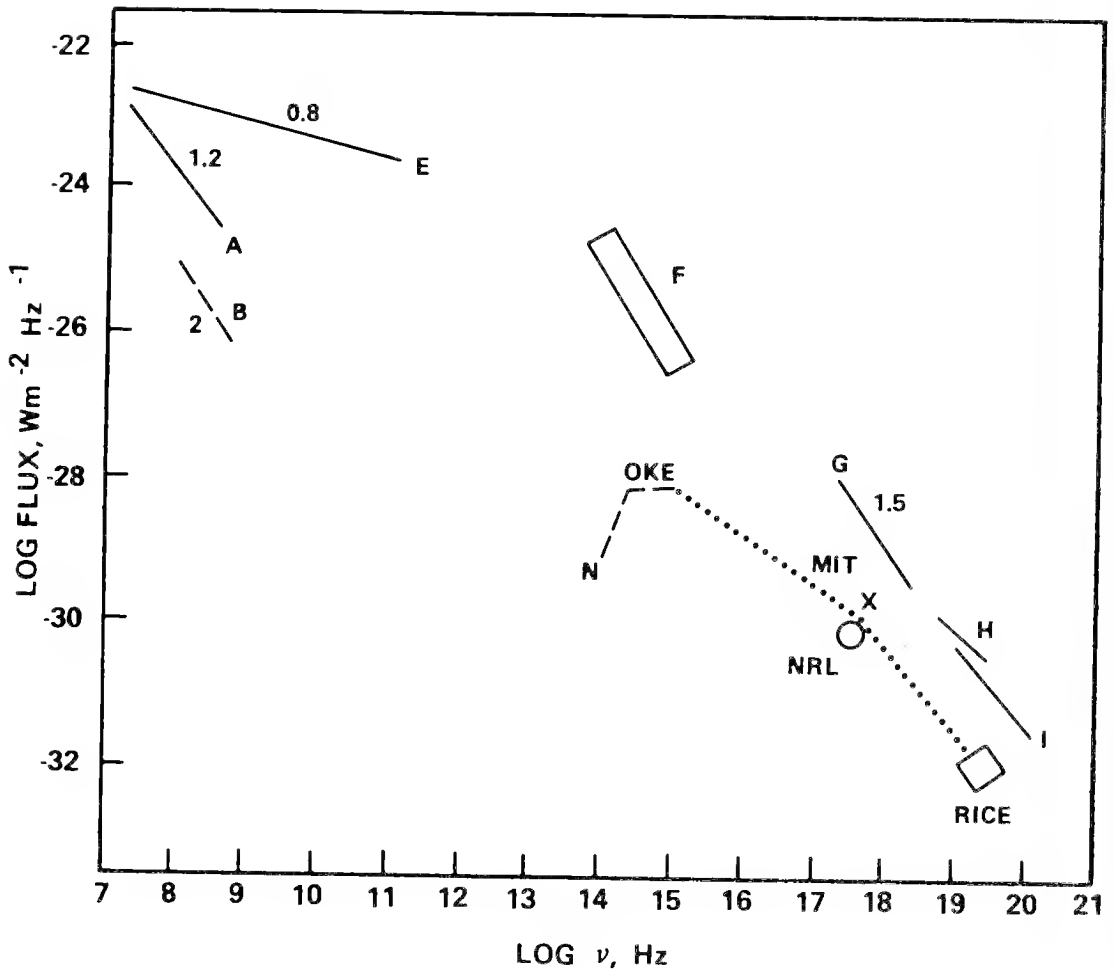


FIGURE 2. Composite spectrum of Tau X-1 and NP 0532.

pulse and interpulse structure should be analyzed, as well as the general problem of pulsar models and neutron-source energizing systems.

DIFFUSE BACKGROUND RADIATION

The entire sky is filled with a diffuse, nearly isotropic X-ray background radiation which is believed to be of extragalactic origin. This background radiation was first observed in the X-ray region, then in the low energy gamma region, and most recently in the gamma region above $1.60210 \times 10^{-13} \text{J}$ (100 MeV). The values of the intensity and spectral composition of this background radiation (in the X-ray region) set significant bounds on the temperature and density of the intergalactic gas and (in the gamma-ray region) on the density of energetic electrons in intergalactic space. These matters bear directly on the question of closed versus open universe.

The accurate form of the energy spectrum of the diffuse cosmic X rays provides an important key to the mechanism, or mechanisms, of origin (Fig. 3 [50]). Although many observations have been made, some

Cosmic X-Ray Observations

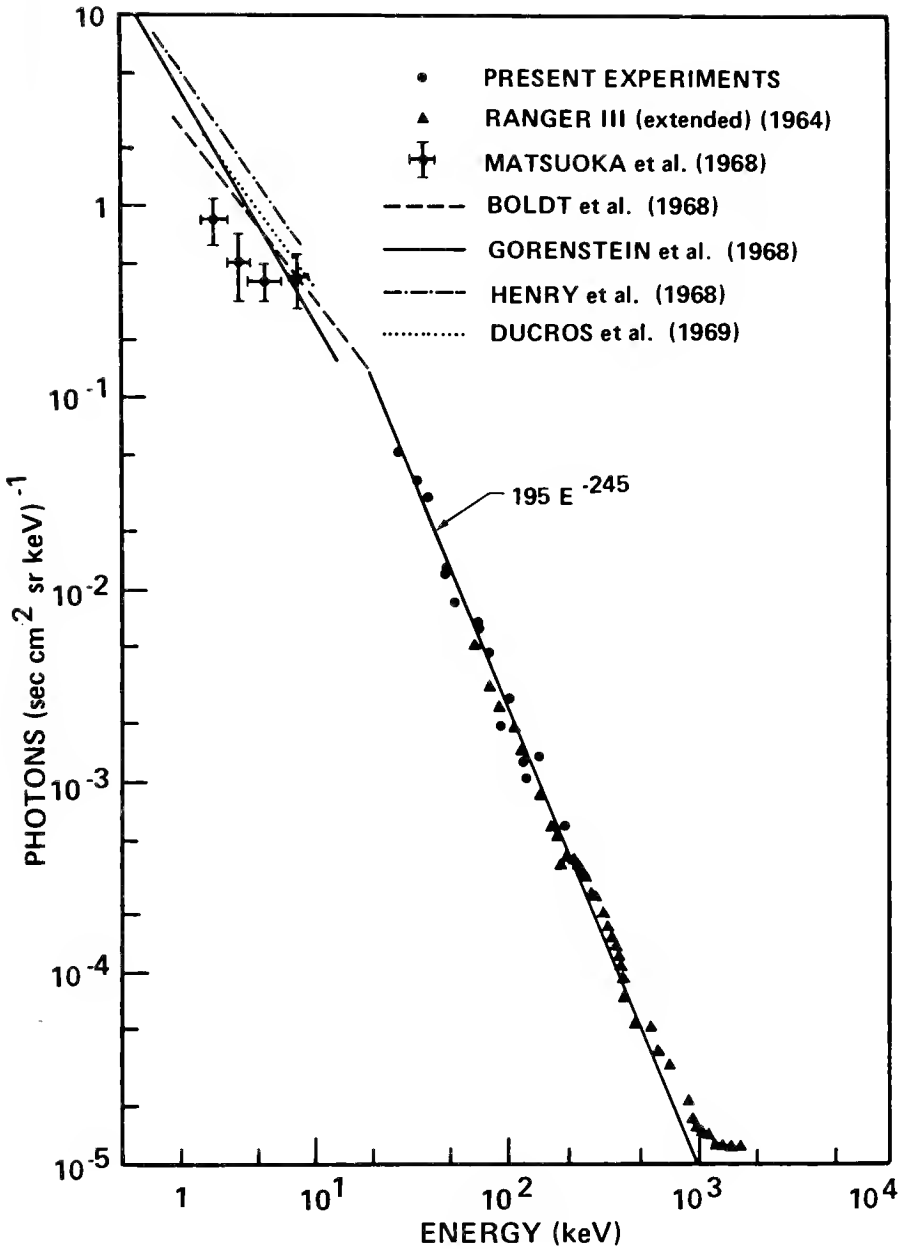


FIGURE 3. Spectrum of diffuse background radiation.

uncertainty persists throughout the energy range studied. The evidence for a break in the diffuse X-ray spectrum between 1.60210×10^{-15} and 1.60210×10^{-14} J (10 and 100 keV), with a steeper energy spectrum at the higher energy, is fairly strong. But neither the energy at which this break occurs nor the change in spectral index has been accurately established. Some authors place the break between 1.60210×10^{-15} and 3.20420×10^{-15} J (10 and 20 keV) with a change about unity in the spectral index [51, 52]; others argue that the X-ray spectrum steepens around 9.61260×10^{-15} J (60 keV) with a change in spectral index of about one-half power [53]. Therefore, accurate measurement of the spectrum of the X-ray background is highly desirable. These background

measurements can decide among different physical processes such as emission from a hot, intergalactic gas, inverse Compton interactions between the 3°K blackbody radiation and cosmic electrons, or the superposition of the X-ray emission from very distant, unresolved galaxies. The celestial distribution of the X-ray background as a function of energy is also needed to separate extragalactic, galactic, and local X-ray production.

Presently, the background radiation seems to be resolvable into at least two components [6]: hard X rays (1 to 1000 keV) which may be associated with the interaction of cosmic rays and the microwave photon of the cosmological background, and soft X rays (<1 keV) which may originate as bremsstrahlung from hot intergalactic gas. The third hypothesis (superposition of sources) may possibly contribute a certain degree to both the hard and soft X-ray fluxes [54].

Much work is clearly seen ahead in the study of the diffuse cosmic X-ray background radiation. The origin of this radiation is still highly debatable and accurate electron-spectrum measurements are still desired. The precise source location over the entire celestial sphere is also greatly needed.

SUMMARY

Many more studies and experiments must be conducted in cosmic X-ray astronomy. Among the urgent needs is an all-sky survey determining the total number of sources, their spectral emission, and their distribution. This survey should result in a catalog of X-ray objects similar to the 3C catalog of radio sources. Spectral intensities, shapes, and characteristics should be secured. Polarization studies with polarimeters and emission-line searches with Bragg crystal spectrometers should be utilized. These data could give basic information, along with the spectral shape data, about the source physical process — whether thermal or nonthermal, bremsstrahlung, or synchrotron. With modulation collimator techniques, precise source location and positional analysis, as well as accurate source size measurements, can be accomplished. These data, when properly correlated with active ground-based optical observations of the error boxes of the X-ray emission region, will possibly yield optical identification, which should show interesting correlations. That is, maybe the X-ray emission is connected with or related to flare stars, magnetic stars, planetary nebulae, old novae or supernovae, WR stars, or, possibly, Seyferts. These accurate positional measurements, when correlated with their respective optical objects, will give accurate distance determinations and luminosity measurements. It may also allow spectroscopic and radio measurements to be made as well. Periodicity should be searched for in a range of from several milliseconds to one or two seconds, as well as general variability. It should be determined if sources exist whose intrinsic brightness is great at hard X-ray energies, yet indistinguishable at soft X-ray energies, or vice versa. The attenuation characteristics or absorption effects should be secured for interstellar and intergalactic space. Also, the origin of the diffuse background and how this background emission relates to an expanding universe should be investigated. All of these basic

Cosmic X-Ray Observations

requirements can be achieved by prolonged observation of these X-ray sources from a large orbiting platform in space. It should be noted that such an experimental assembly for the prolonged study of the celestial sphere at high energy frequencies is now in preparation. Hopefully then, new knowledge will be determined in the near future to make possible the answers to posed questions and fulfillment of the needs of cosmic X-ray astronomy.

REFERENCES

1. Wilson, R. M. Descriptive survey of identified X-ray sources. J. Ala. Acad. Sci. 42(January 1971):34-46.
2. Giacconi, R., H. Gursky, F. Paolini, and B. Rossi. Evidence for X-rays from outside the solar system. Phys. Rev. 9(December 1962):439-443.
3. Friedman, H. Cosmic X-rays and gamma rays. Astron. and Aeron. 3(October 1965):8-12.
4. Wilson, R. M., J. M. Reynolds, and S. A. Fields. A stellar X-ray astronomy summary and bibliography. NASA TM X-53952 (September 30, 1969).
5. Friedman, H. Cosmic X-rays. Nature 220(November 30, 1968):862-865.
6. Friedman, H. X-ray and gamma-ray astronomy. Science 166(November 21, 1969):1045-1046.
7. Doyle, R. O. (ed.). A long-range program in space astronomy position. Paper of the Astronomy Missions Board. NASA SP-213 (July 1969).
8. Bowyer, C. S., E. T. Byram, T. A. Chubb, and H. Friedman. Lunar occultation of X-ray emission from the Crab Nebula. Science 146(November 1964):912-917.
9. Oda, M., H. Bradt, G. Garmire, G. Spada, B. V. Sreekantan, H. Gursky, R. Giacconi, P. Gorenstein, and J. R. Waters. The size and position of the X-ray source in the Crab Nebula. Astrophys. J. (1967):L5-L11.
10. Staelin, D. H., and E. C. Reifenshtein, III. Pulsating radio sources near the Crab Nebula. Science 162(December 1968):1481-1483.
11. Cocke, W. J., M. J. Disney, and D. J. Taylor. Discovery of optical signals from pulsar NP 0532. Nature 221(February 8, 1969):525-527.
12. Nather, R. E., B. Warner, and M. McFarlane. Optical pulsations in the Crab Nebula pulsar. Nature 221 (February 8, 1969):527-529.

13. Fritz G., R. C. Henry, J. F. Meekins, T. A. Chubb, and H. Friedman. X-ray pulsar in the Crab Nebula. *Science* 164(May 9, 1969):709-712.
14. Sandage, A., P. Osmer, R. Giacconi, P. Gorenstein, H. Gursky, J. Waters, H. Bradt, G. Garmire, B. V. Sreekantan, M. Oda, K. Osawa, and J. Jugaku. On the optical identification of Sco X-1. *Astrophys. J.* 146(1966):316-322.
15. Shklovsky, I. S. On the nature of the source of X-ray emission of Sco XR-1. *Astrophys. J.* 148(1967):L1-L4.
16. Sartori, L., and P. Morrison. Thermal X-rays from non-thermal radio sources. *Astrophys. J.* 150(1967):385-403.
17. Prendergast, K. H., and G. R. Burbidge. On the nature of some galactic X-ray sources. *Astrophys. J.* 151(1968):L83-L88.
18. Cameron, A. G. W., and M. Mack. Stellar accretion and X-ray emission. *Nature* 215(July 1967):464-466.
19. Morton, D. C. Neutron stars as X-ray sources. *Nature* 201(March 1964):1308-1309.
20. Manley, O. P., and S. Olbert. Models of X-ray stars. *Astrophys. J.* 157(1969):223-246.
21. Evans, W. D., R. D. Belian, and J. P. Conner. Observations of the development and disappearance of the X-ray source Centaurus XR-4. *Astrophys. J.* 159(1970):L57-L60.
22. Thomas, R. M., G. Buselli, M. C. Clancy, and P. J. N. Davison. Balloon observations of a new-born X-ray source. *Astrophys. J.* 158(1969):L151-L154.
23. Conner, J. P., W. D. Evans, and R. D. Belian. The recent appearance of a new X-ray source in the southern sky. *Astrophys. J.* 157(1969):L157-L159.
24. Kitamura, T., M. Matsuoka, S. Miyamoto, M. Nakagawa, M. Oda, Y. Ogawara, and K. Takagishi. Observation of a new X-ray source. *Nature* 224(November 1969):784-785.
25. Mark, H., R. Price, R. Rodrigues, F. D. Seward, and C. D. Swift. Detection of X-rays from the large magellanic cloud. *Astrophys. J.* 155(1969):L143-L144.
26. Byram, E. T., T. A. Chubb, and H. Friedman. X-ray survey of Centurus A. *Science* 169(July 1970):366-368.
27. Haymes, R. C., D. V. Ellis, G. J. Fishman, S. W. Glenn, and J. D. Kurfess. Search for gamma radiation from Centaurus A. *Astrophys. J.* 155(1969):L31-L34.

Cosmic X-Ray Observations

28. Bowyer, C. S., M. Lampton, and J. Mack. Detection of X-ray emission from 3C 273 and NGC 5128. *Astrophys. J.* 161(1970):L1-L7.
29. Friedman, H., and E. T. Byram. X-rays from sources 3C 273 and M87. *Science* 158(October 1967):257-259.
30. Friedman, H., E. T. Byram, and T. A. Chubb. X-rays from source 3C273. *Science* 159(February 1968):747-748.
31. Tucker, W. H., and C. B. Tarter. X-ray emission in the nuclei of Seyfert galaxies. *Astron. J.* 73(1968):901-903.
32. Burginyon, G. A., R. J. Grader, R. W. Hill, R. E. Price, R. Rodrigues, F. D. Seward, C. D. Swift, W. A. Hiltner, and E. J. Mannery. Scorpius XR-1: Some X-ray and optical observations (May 1969). *Astrophys. J.* 161(1970):987-995.
33. Mark, H., R. E. Price, R. Rodrigues, F. D. Seward, C. D. Swift, and W. A. Hiltner. Further simultaneous observations of the optical and X-ray spectra of Sco X-1. *Astrophys. J.* 156(1969):L67-L72.
34. Grader, R. J., R. W. Hill, F. D. Seward, and W. A. Hiltner. The soft X-ray spectra of three cosmic sources and simultaneous optical observations of the Sco XR-1. *Astrophys. J.* 159(1970):201-214.
35. Hudson, H. S., L. E. Peterson, and D. A. Schwartz. Simultaneous X-ray and optical observations of Sco X-1 flares. *Astrophys. J.* 159(1970):L51-L55.
36. Toor, A., F. D. Seward, L. R. Cathey, and W. E. Kunkel. A measurement of the optical and X-ray emission from Scorpius X-1 and the diffuse background. *Astrophys. J.* 160(1970):209-213.
37. Chodil, G., H. Mark, R. Rodrigues, F. D. Seward, C. D. Swift, I. Turiel, W. A. Hiltner, G. Wallerstein, and E. J. Mannery. Simultaneous observations of the optical and X-ray spectra of Sco XR-1. *Astrophys. J.* 154(1968):645-654.
38. Angel, J. R. P., R. Novick, P. Vanden Bout, and R. Wolff. Search for X-ray polarization in Sco X-1. *Phys. Rev. Letters* 22(1969):861-865.
39. Angel, J. R. P. Polarization of thermal X-ray sources. *Astrophys. J.* 158(1969):219-224.
40. Wolff, R. S., J. R. P. Angel, R. Novick, and P. Vanden Bout. Search for polarization in the X-ray emission of the Crab Nebula. *Astrophys. J.* 160(1970):L21-L25.
41. Tucker, W. Cosmic X-ray sources. *Astrophys. J.* 148(1967):745-765.
42. Tucker, W., and R. J. Gould. Radiation from a low density plasma at $10^6^\circ - 10^8^\circ\text{K}$. *Astrophys. J.* 144(1966):244-258.

43. Holt, S. S., E. A. Boldt, and P. J. Serlemitsos. Iron-line emission from X-ray sources. *Astrophys. J.* 154(1968):L137-L140.
44. Fritz, G., J. F. Meekins, R. C. Henry, and H. Friedman. On X-ray line emission from Scorpius XR-1. *Astrophys. J.* 156(1969):L33-L36.
45. Holt, S. S., E. A. Boldt, and P. J. Serlemitsos. Search for line structure in the X-ray spectrum of Sco X-1. *Astrophys. J.* 158(1969): L155-L158.
46. Acton, L. W., R. C. Catura, J. L. Culhane, and P. C. Fisher. X-ray line emission from Scorpius X-1. *Astrophys. J.* 161(1970):L175-L179.
47. Hewish, A., S. J. Bell, J. D. H. Pilkington, P. F. Scott, and R. A. Collins. Observation of a rapidly diffusing pulsating radio source. *Nature* 217(February 24, 1968):709-713.
48. Hewish, A. Pulsars. *Sci. Am.* 219(October 1968):25-35.
49. Friedman, H. Pulsars. *Astron. and Aeron.* 8(April 1970):22-25, 61, 95.
50. Bleeker, J. A. M., and A. J. M. Deerenberg. The diffuse cosmic X-ray background from 20 to 220 keV. *Astrophys. J.* 150(1970): 215-228.
51. Henry, R. C., G. Fritz, J. F. Meekins, H. Friedman, and E. T. Byram. Possible detection fo a dense intergalactic plasma. *Astrophys. J.* 153(1968):L11-L18.
52. Boldt, E. A., U. D. Desai, and S. S. Holt. 2-20 keV spectrum of X-rays from the Crab Nebula and the diffuse background near Galactic Anticenter. *Astrophys. J.* 156(1969):427-436.
53. Gorenstein, P., E. M. Kellogg, and H. Gursky. The spectrum of diffuse cosmic X-rays, 1-13 keV. *Astrophys. J.* 156(1969):315-324.
54. Gould, R. J. Origin of cosmic X-rays. *Am. J. Phys.* 35(1967):376-393.

Telemetered Thermal Responses

TELEMETERED THERMAL RESPONSES OF A SPECIMEN OF THE VIRGINIA OPOSSUM

Gary Dills
Department of Biology
University of Alabama, University

INTRODUCTION

According to Clemens (1968), placental and marsupial mammals began their phylogenetic dicotomy during the late Cretaceous period; yet, they have been phylogenetically distinct throughout the Cenozoic era. Marsupials generally have been considered the least homiothermic of the two groups (Morrison, 1946). Several investigators have reported that body temperature in several marsupials is quite liable when compared to most non-hibernating placental mammals whose body temperature remains constant within 2°C over a wide range of ambient temperature (Eisentraut, 1968; Morrison and McNab, 1962; Bartholomew and Hudson, 1962; Higginbotham and Koon, 1955). Morrison (1965) and Godfrey (1968) found certain marsupial species that showed daily fluctuations in body temperature with minimum temperatures occurring during the daylight hours. However, recent studies by MacMillen and Nelson (1969) and Waring et al. (1966) revealed little difference between the two mammalian groups in relation to their homiothermic adaptabilities.

In 1955, Higginbotham and Koon reported on temperature regulation and thermoregulatory mechanisms in the Virginia opossum (*Didelphis marsupialis*). They measured rectal and surface temperatures with wire thermocouples and found the body temperature of the opossum to be quite liable. Mackay (1968) reported that significant amounts of heat can be carried along the wires of a thermocouple either to or from the site under investigation, thus changing its temperature from normal.

This study proposes, by means of a surgically implanted temperature transmitter, (1) to determine the thermoregulatory capacity of the Virginia opossum, and (2) to monitor the diel temperature of the animal. In addition, the principle of monitoring body temperature by telemetry was evaluated.

MATERIALS AND METHODS

The thermal responses of a male, young-of-the-year, opossum were monitored. Since conception in opossums occurs in February (Hartman, 1952) and the study was conducted in December, the approximate age of the animal was 11 months. The animal was held singly in a cage (75x38x38 cm) in a constant temperature room with a 12-hour photoperiod and fed a variable diet consisting of dog food, fruits, eggs, and a constant water supply.

As described by Mackay (1968), a blocking-oscillator temperature transmitter was employed in this study (Fig. 1). The assembled transmitter (4x2 cm) was first coated with paraffin (M.P. 56°C), then an

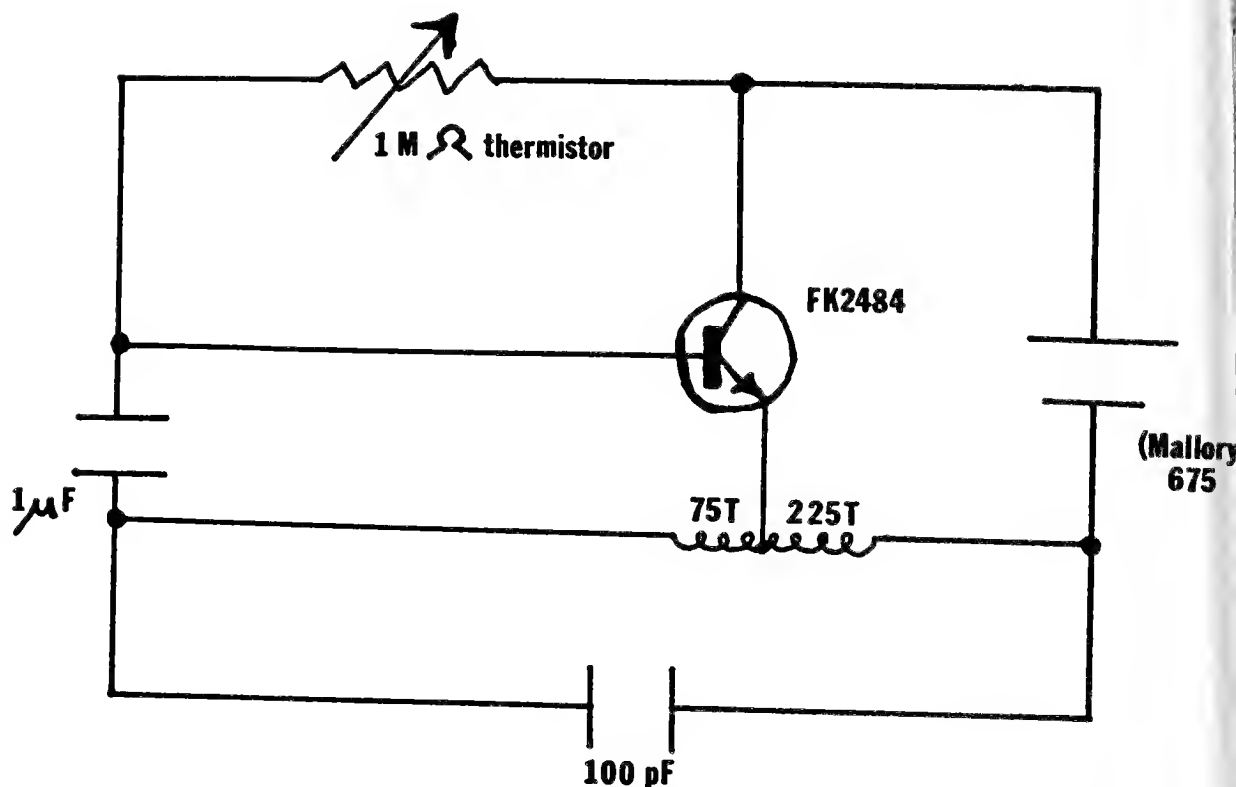


FIGURE 1. The circuitry of the blocking-oscillator temperature transmitter employed in this study.

outer layer of silicone rubber was applied. When fifty different coating materials were tested by Mackay (1968), paraffin was found to be the least permeable to body fluids. The transmitter produced audible clicks at a rate dependent upon the temperature of the thermistor. Transmission distance was approximately 1 meter with a frequency of 600-1200 kHz. A small pocket AM receiver and a stop-watch were used to monitor the number of clicks per minute.

Basic surgical procedures were followed while implanting the transmitter. The unit was first washed in soap and water and then soaked in 95% alcohol for 10 minutes. Nembutol was injected intra-peritoneally in increments of 0.5 cc until a total of 2.0 cc was administered. Then a local xylocaine anesthetic was injected at the site of the incision. It was felt that such a combination of anesthetics would be safer than a more massive general anesthetic. The unit was quickly inserted through a 2-inch incision made laterally between the rib cage and pelvic girdle. The animal was given antibiotics at the end of the 15-minute operation and again 24 hours later.

Prior to implantation, the transmitter was calibrated by placing a mercury thermometer and the unit into a beaker of 0.9% saline solution. The temperature of the solution was slowly increased and the number of clicks for several temperature readings was recorded. A standard curve was then plotted as shown in Figure 2.

Telemetered Thermal Responses

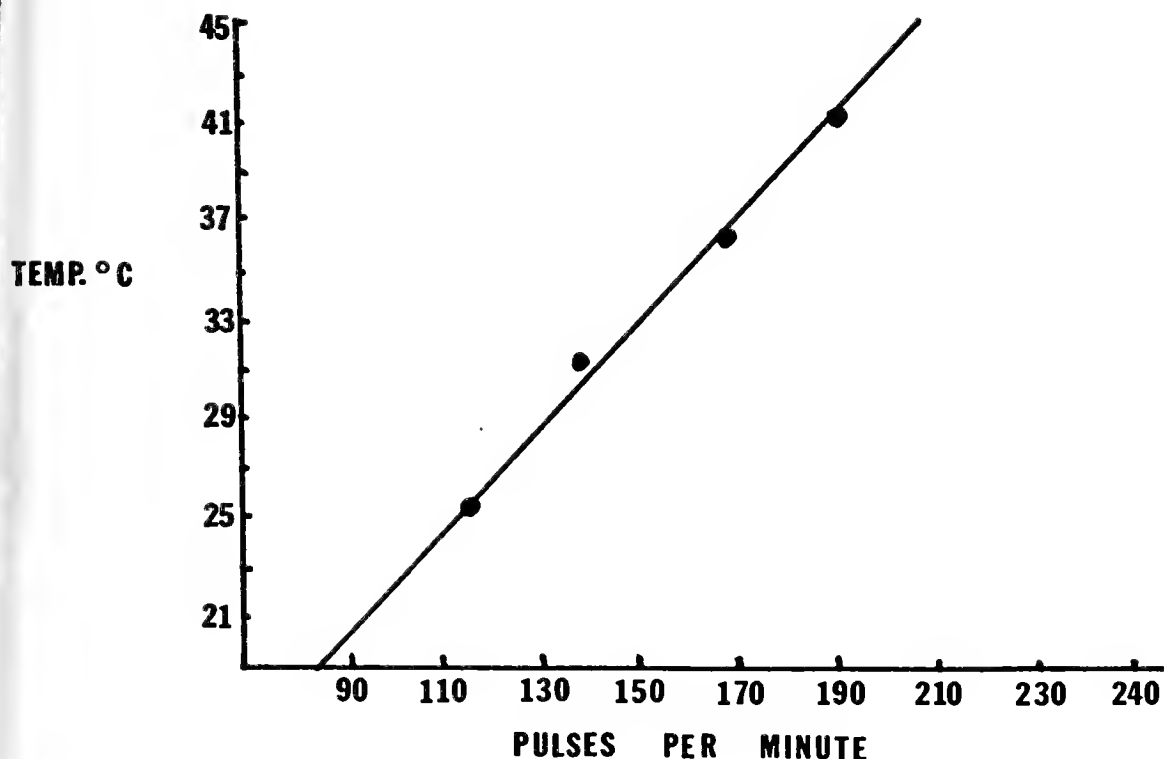


FIGURE 2. Calibration curve for blocking-oscillator temperature transmitter.

Fourteen days after the implantation, the thermal responses of the animal were monitored while exposed to slowly increasing ambient temperatures in a thermostatically controlled environmental chamber. Relative humidity measurements were not made. To determine diel temperature fluctuations, the animal was placed in a constant temperature room (21.0°C) while hourly body temperature measurements were made.

RESULTS AND DISCUSSION

In the first experiment, the animal was exposed to an increasing ambient temperature from 21.0° to 38.0°C (Fig. 3). The deep-core temperature of the opossum increased from 35.8° to 42.4°C, representing a change of 6.6°. Initially the animal was outstretched on the abdomen with mouth closed. The opossum began to salivate profusely at an ambient temperature of 36.0°C. At 38.0° the animal began to walk around and the eyes twitched occasionally.

The opossum appeared to control its body temperature effectively until an ambient temperature of 38.0°C was reached. At this temperature thermoregulatory mechanisms, such as panting and salivating, were employed but deep-core temperature tended to parallel increases in ambient temperature.

In the second experiment, the animal was placed in an environmental chamber with an ambient temperature of -2°C. Over a 2-hour period, the ambient temperature slowly increased from -2°C to 21°C while

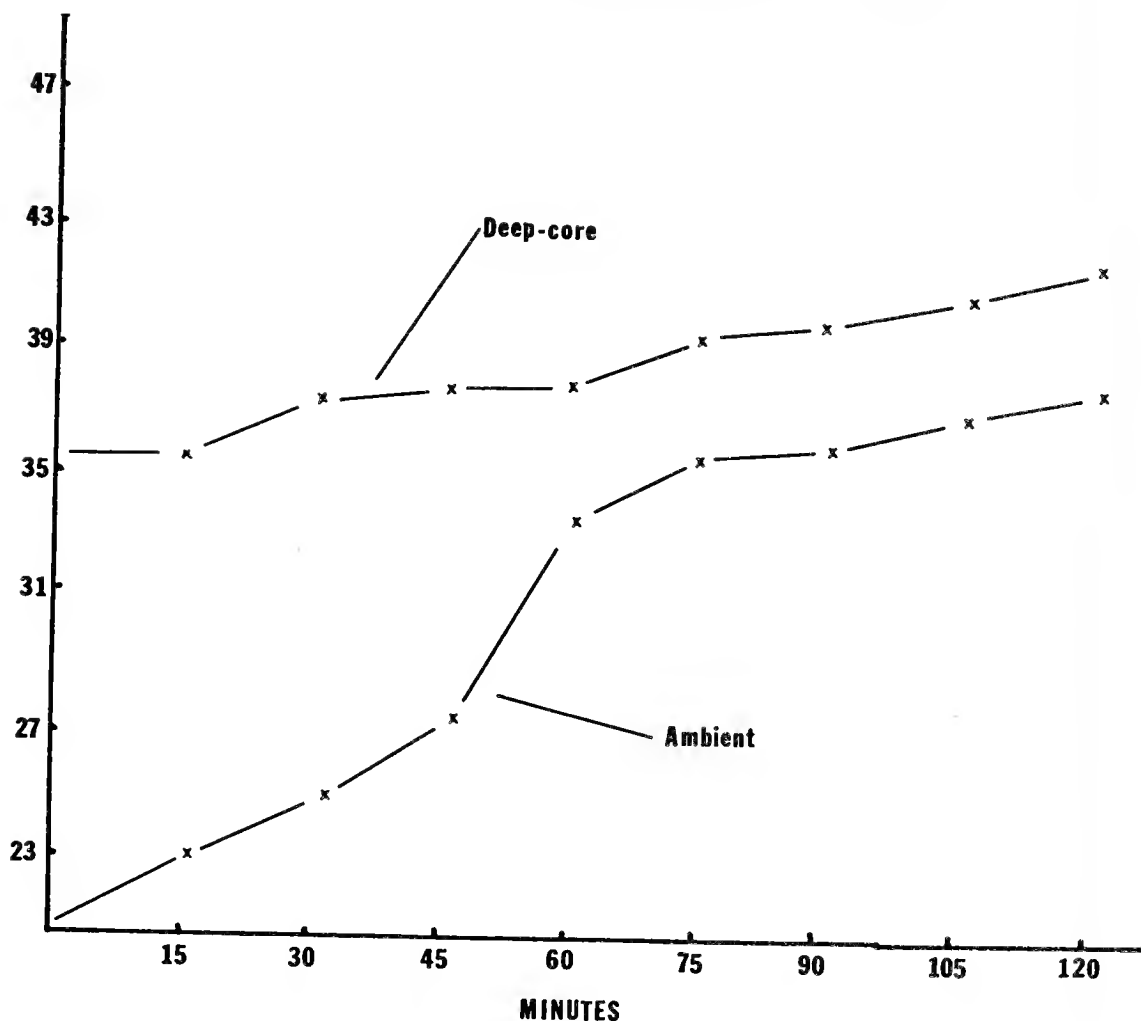


FIGURE 3. Deep-core body temperature of opossum in response to increasing ambient temperature.

deep-core temperature increased from 34.5° to 38.0°C (Fig. 4). The animal shivered spontaneously until an air temperature of 7.5°C was reached.

As shown in Table 1, the opossum could best cope with low ambient temperatures. At high air temperatures the deep-core temperature

TABLE 1. Changes in deep-core temperature (T_{dc}) responses of a male opossum exposed to increasing ambient temperatures (T_a).

Experiment	T_a	T_{dc}	ΔT_a	ΔT_{dc}
1	21 - 38°	35.8 - 42.4°	17°	6.6°
2	-2 - 21°	34.5 - 38.0°	23°	3.5°

Telemetered Thermal Response

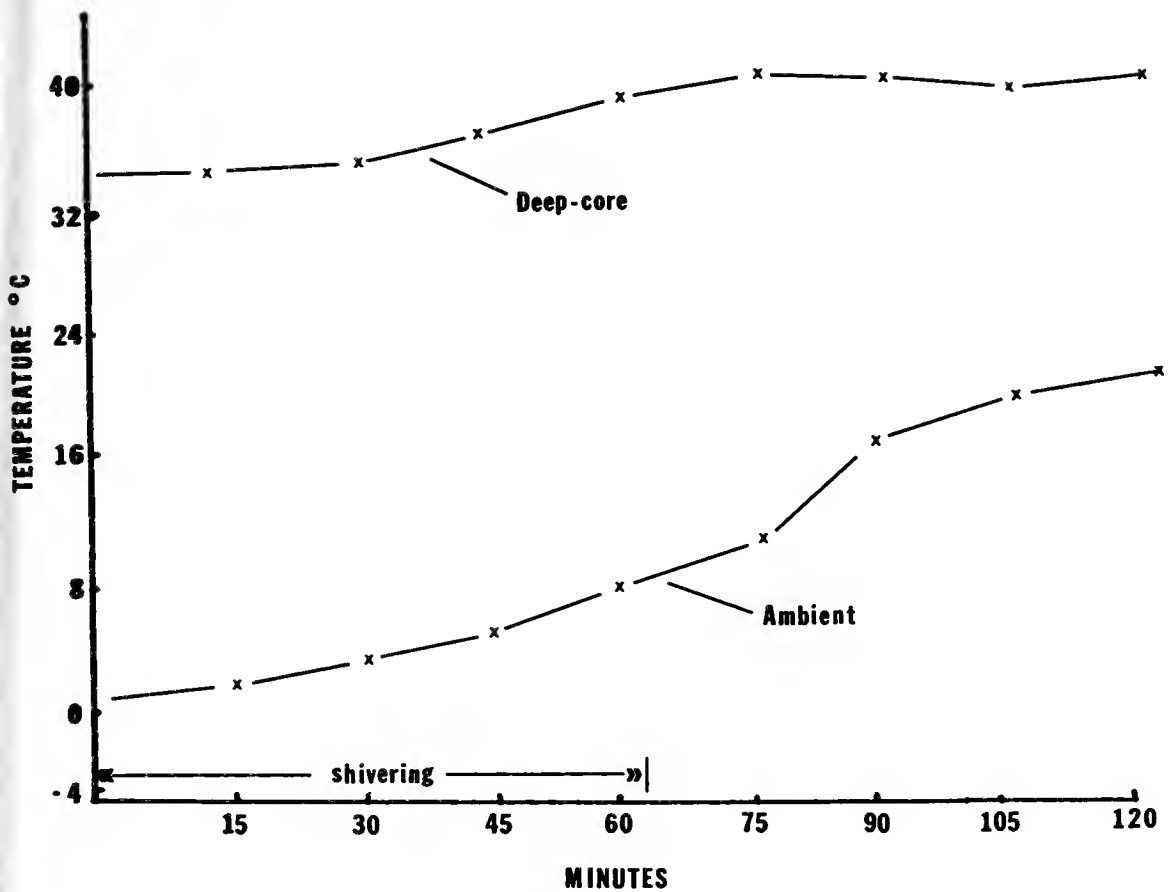


FIGURE 4. Deep-core body temperature of opossum exposed to a low ambient temperature that is subsequently increased.

changed 6.6° while at low air temperatures the body temperature changed only 3.5°. Deep-core body temperature closely followed the changing ambient temperature, as shown by Figures 3 and 4. These data tend to agree with an extensive series of temperature measurements made on humans by Fox et al. (1961). They concluded that, "temperature in the small intestine accorded most closely with rectal temperature but was more responsive to external temperature change."

Shivering was the most obvious thermoregulatory mechanism employed by the animal at low ambient temperature, while salivating and panting appeared to be the most important mechanisms at higher air temperatures. In opossums, a third type of thermoregulatory mechanism was reported by Higginbotham and Koon (1955) and involved the spreading of saliva over body surfaces in order to cope with ambient temperatures above 38.0°C. This mechanism was not observed in this study.

The diel temperature fluctuations of the opossum showed highest temperatures occurring during the night hours with an overall diel temperature change of 3.7°C (Fig. 5). These data tend to agree with daily temperature measurements of several marsupial species taken by Morrison (1965) and Godfrey (1968).

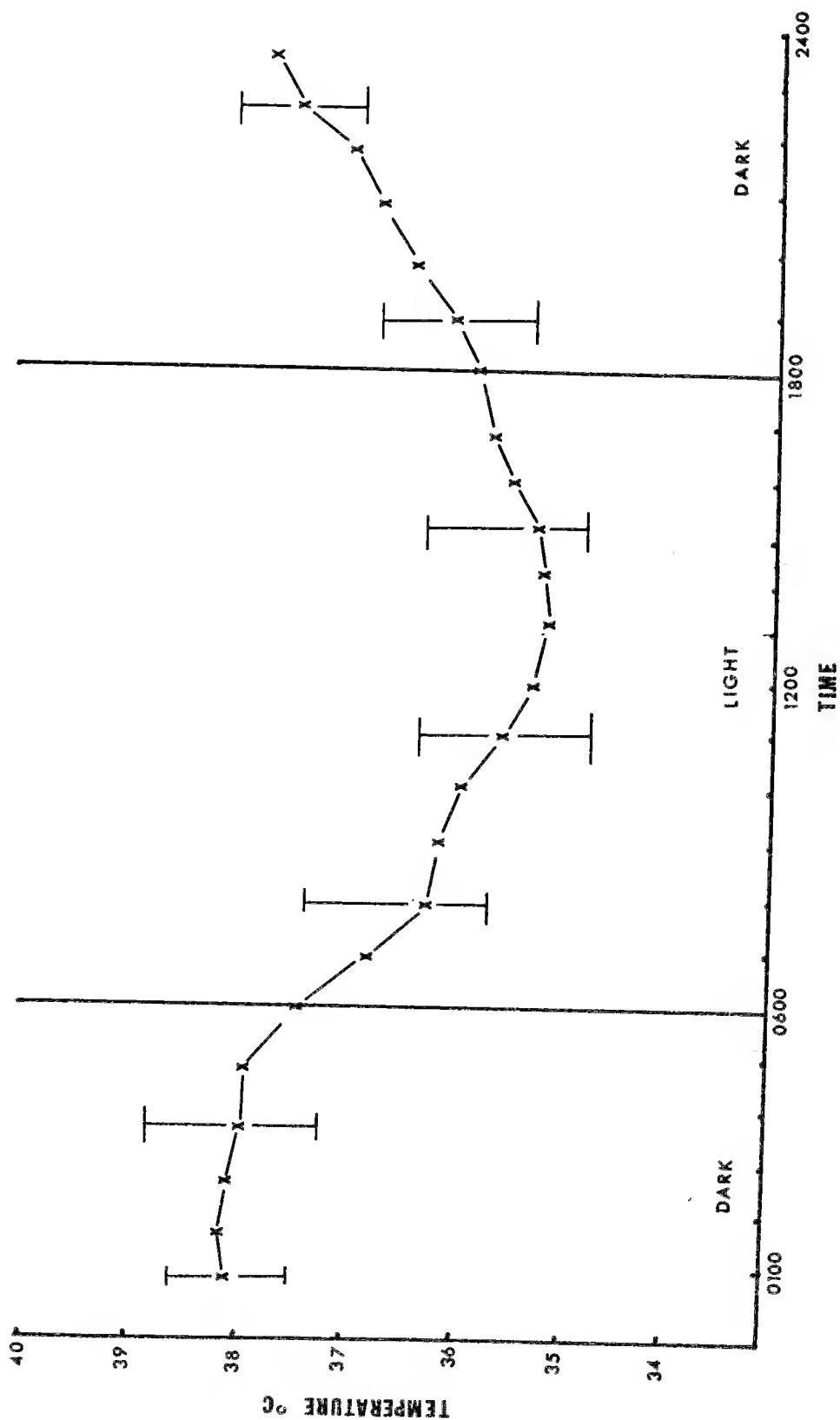


FIGURE 5. Diel temperature fluctuations of a male opossum. (Bar = range of values; x = mean; ambient temperature = 21.0°C).

Telemetered Thermal Responses

SUMMARY AND CONCLUSIONS

The homiothermic adaptabilities of the Virginia opossum were most effective at low ambient temperature rather than high air temperatures. Salivating and panting were thermoregulatory mechanisms employed at high temperatures while shivering was utilized at low ambient temperatures. The deep-core body temperature of the opossum was shown to be quite liable with an overall temperature change of 7.9°C. Daily fluctuations in body temperature showed minimum temperature occurring during the daytime.

In conclusion, it is believed that monitoring body temperature by telemetry has several advantages over conventional measurements by thermocouples or temperature probes. First, in ordinary measurements with a thermocouple, the reference temperature may be the ambient temperature to which the rest of the circuit is exposed. In telemetry a reference junction can be placed outside the animal and all readings are then referred to this possibly changing temperature. Secondly, the subject is allowed to remain in a relatively normal physiological and psychological state by not disturbing his normal pattern of activity. In this study the animal was usually unaware that the investigator was present while measurements were being taken. Thirdly, with telemetry there are no wires for the animal to pull loose or become entangled in. In this study, the implanted transmitter did not appear to cause the animal any undue discomfort or alter his daily pattern of activity.

LITERATURE CITED

- Bartholomew, G. A., and J. W. Hudson. 1962. Hibernation, estivation, temperature regulation, evaporative water loss, and heart rate of the pigmy opossum, *Cercoartus nanus*. *Physiol. Zool.* 35:94-107.
- Clemens, W. A. 1968. Origin and early evolution of marsupials. *Evolution* 22:1-18.
- Eisentraut, M. 1968. Heat regulation in primitive mammals and tropical species. *Bull. Mus. Comp. Zool. Harv.* 124:31-43.
- Fox, R. H., R. Goldsmith, and H. S. Wolf. 1961. Thermal regulatory adaptabilities in marsupials. *J. Physiol.* 160:22-23.
- Godfrey, G. K. 1968. Body-temperature and torpor in *Sminthopsis crassicaudata* and *S. larapinata* (Marsupialia: Dasyuridae). *J. Zool., Lond.* 156:499-511.
- Hartman, C. G. 1952. Possums. Univ. of Texas Press, Austin.
- Higginbotham, A. C., and W. E. Koon. 1955. Temperature regulation in the Virginia opossum. *Physiol. Zool.* 11:69-71.
- Mackay, R. S. 1968. Bio-medical Telemetry: Sensing and Transmitting Biological Information from Animals to Man. Wiley & Sons, New York. 388 pp.

Journal of the Alabama Academy of Science

- MacMillen, R. F., and J. E. Nelson. 1969. Bioenergetics and body size in dasyurid marsupials. *Am. J. Physiol.* 217(4):1246-1251.
- Morrison, P. R. 1946. Temperature regulation in Central American opossums. *J. Cell. and Comp. Physiol.* 27:125-137.
- Morrison, P. R. 1965. Body temperature in some Australian mammals. IV. Dasyuridae. *Aust. J. Zool.* 13:173-187.
- Morrison, P. R., and B. K. McNab. 1962. Daily torpor in a Brazilian murine opossum (*Marmosa*). *Comp. Biochem. Physiol.* 6:57-68.
- Waring, H. R., R. J. Moir, and C. H. Tyndale-Biscoe. 1966. Comparative physiology of marsupials, pp. 237-376. *In Advances in Comparative Physiology and Biochemistry*, Vol. 2, O. Lowenstein [ed.]. Academic Press, New York.

Harding's Birmingham Address

PRESIDENT WARREN G. HARDING'S BIRMINGHAM ADDRESS

Jacquelyn M. Diener
Auburn, Alabama

INTRODUCTION

On October 26, 1921, approximately 45,000 people, black and white, gathered in Wilson Park, Birmingham, Alabama, to hear an address by Warren G. Harding, 29th President of the United States. The occasion for this address was the celebration of the semi-centennial birthday of the city of Birmingham. People in a merry-making mood had gathered from miles around to participate in the festivities that included: a Semi-centennial Queen Contest of beautiful girls from each of the sixty-seven Alabama counties; a grand floral parade led by President and Mrs. Harding, Governor Thomas E. Kilby, other heads of State, all the members of the Alabama Senate and House of Representatives, and 1,000 members of the American Legion; a fashion show by New York models and Ziegfeld girls; an automobile show; the laying of the cornerstone of a million dollar Masonic Temple; the inauguration of the president of Birmingham-Southern College at which President Harding received an honorary Doctor of Laws Degree. But most of all, people, wearing Harding buttons which had been distributed throughout Alabama, came to see the President of the United States and to hear him speak.^{1,2,3,4,5}

The purpose of this study was to promote better understanding of: 1) Harding's choice of the racial problem for the subject of his Birmingham Address, 2) the similarities of Harding's and Booker T. Washington's philosophies on the place of the Negro in the United States, and 3) the reaction of people to the Birmingham Address. The importance of this study may be measured by the insight it gives into the historical background of and possible solutions for current racial problems.

The scope of the study was restricted to published literature. Only selected facts related to the Birmingham Address are presented. These facts will be elaborated for purposes of clarification. The data were taken from books, newspapers, and one term paper listed in the bibliography. Notes were taken on selected topics and synthesized.

ANALYSIS OF DATA - THE ADDRESS

An event in history, such as the Birmingham Address, can be better understood by examining the reasons for it. Why did Warren G. Harding choose to speak on the touchy subject of the racial problem? What were his motives? What did he hope to accomplish?

CHOICE OF SUBJECT

Harding did not express his reasons for choosing to speak on the racial problem in his Birmingham Address. Some possible reasons were:

Harding's nature. In direct contrast to some who pictured Harding as a selfish, stern man, a philanderer, others repudiated this view because there was no evidence. Instead, they pictured him as a good man, one who was kind, patient, fair minded, and considerate; a man whose good

intentions were always abundant, a friend of the people; a leader with a keen, humble sense of obligation to all of his fellow citizens.^{6,7,8,9,10,11}

Harding as a harmonizer. He firmly believed that conciliation and harmony were superior to obstruction and strife. He was a great harmonizer in the Senate.¹² He was sincere in his desire to act as mediator between blacks and whites on a range of racial problems.¹³

Harding's national view. He believed in staunch Americanism as opposed to sectionalism and internationalism. His attitude and actions were "America first!"¹⁴ He exhorted one audience, "think more of what you can do for your government than what your government can do for you."¹⁵ In his first congressional message, April, 1921, Harding urged creation of an interracial commission "to formulate, if not a policy, at least a national attitude of mind calculated to bring about the most satisfactory possible adjustment of relations between races."¹⁶

Harding's promises to the Negroes. In his campaign speeches he promised Negroes that he would increase Negro patronage, and work for an antilynching bill.¹⁷ Lynchings debased citizenship, caused moral structure to break down, and created economic problems. Three thousand seven hundred twenty-four people were lynched in the United States from 1889 through 1930, over four-fifths of these were Negroes.¹⁸ Four hundred thirty-one people were lynched from 1915 through 1921, forty-three whites and three hundred eighty-eight blacks.¹⁹ When thousands of on-lookers watched a lynching then denied in court any knowledge of it, the very basis for decent human relations in that community was violated. Such disregard of the Negroes' right to trial diminished the Negroes' faith in their white neighbors and in their government. Lynchings were detrimental to both blacks and whites.²⁰ To solve these problems, Harding requested Congress, in his first Congressional message, to pass an antilynching law.²¹ Related to lynchings and other arbitrary actions, Harding made courageous attacks on the politically powerful Ku Klux Klan.²²

Harding's responsibility to the Republican party. Southern Republicans wanted to make the Republican party in the South "lily-white." The possibility of eliminating blacks from the party caused hostility from Southern Negro leaders, influential Northern Negroes, and white sympathizers. Harding as party leader looked for a compromise. He favored that Negroes remain in the Southern Republican party. He therefore seized on the invitation to speak in Birmingham in order to elaborate on his ideas for a revival of Republicanism in the South as well as to offer a blueprint for better race relations in the country as a whole.^{23,24}

Harding's preparation for the Washington Conference. The Washington Conference convened November 11, 1921. As Harding spoke in Birmingham, the Japanese delegates were enroute to the Conference, carrying with them, perhaps, demands for social equality. The *Newark News* considered Harding's Birmingham Address "a bolder undertaking and of vastly greater significance than if he were dealing only with a domestic race

Harding's Birmingham Address

question," and the *Springfield Republican* stated that the address was, for this reason, "a not inappropriate prelude to the Washington Conference."²⁵

Harding wanted to curb Negroes' social ambitions. "In making it clear that he did not believe in the social equality of blacks and whites, the President had in mind to check the too exalted aspirations, which have characterized prominent negroes of New England since the very beginning of his administration."²⁶

Harding expected the South to accept his views and act accordingly. Harding completely misread part of his audience, especially the part composed of the white South. This was substantiated by most of the newspapers that later spoke against his address (See Tables 1-4). Several newspapers indicated that the President displayed chagrin that Southern Senators bitterly criticized his remarks.²⁷ He later declared that nothing could make him more unhappy than to have given offense to the South, but felt that the fundamental truth of what he said could not be challenged.²⁸

EXCERPTS FROM THE ADDRESS

In his Birmingham Address, President Harding praised the South for its industrial recovery, discussed the reunited Nation, outlined the South's early history, and among other topics discussed the racial problem.²⁹ Excerpts from his speech related to the racial problem were:

The time has passed when you are entitled to assume that this problem of races is peculiarly and particularly your problem. More and more it is becoming a problem of the North; more and more it is the problem of Africa, of South America, of the Pacific, of the South Seas, of the world. It is the problem of democracy everywhere.³⁰

Our race problem here in the United States is only a phase of the race issue that the whole world confronts. Just as I do not wish the South to be politically entirely of one party; just as I believe it is bad for the South, and for the rest of the country as well, so I do not want the colored people to be entirely of one party. I wish that both the tradition of a solidly Democratic South and the tradition of a solidly Republican black race can be broken up. Neither political sectionalism nor any system of rigid groupings of the people will in the long run prosper in our country.³¹

I want to see the time when black men will regard themselves as full participants in the benefits and duties of American citizenship; when they will vote for Democratic candidates if they prefer the democratic policy on tariff or taxation or foreign relations or what not. . . . I plead with my own political party to lay aside every program that looks to lining up the black man as a mere political adjunct. Let there be an end of prejudice and demagoguery in this line. . . . Whether you like it or not, unless our democracy is a lie you must

stand for that equality.³²

Harding prefaced the racial part of his speech with a quotation from an article in the *Edinburgh Review* by F. D. Ludard, as follows:

Here, then, is the true conception of the inter-relation of color - complete uniformity in ideals, absolute equality in the paths of knowledge and culture, equal opportunity for those who strive, equal admiration for those who achieve; in matters social and racial a separate path, each pursuing his own inherited traditions, preserving his own race purity and race pride; equality in things spiritual; agreed divergence in the physical and material.

Here, it has seemed to me is a suggestion of the true way out. Politically and economically, there need be no occasion for great and permanent differences, for limitations of the individual's opportunities provided that on both sides there shall be recognition of the absolute divergence in things social and racial. When I suggest the possibility of economic equality between the races I mean it in precisely the same way and to the same extent I would mean it if I spoke of equality of economic opportunity as between members of the same race. In each case I would mean equality proportioned to the honest capacities and deserts of the individual.

Men of both races may well stand uncompromisingly against every suggestion of social equality. Indeed, it would be helpful to have the word 'equality' eliminated from this consideration; to have it accepted on both sides that this is not a question of social equality, but a question of recognizing a fundamental, eternal and inescapable difference. We shall have made real progress when we develop an attitude in the public and community thought of both races which recognize this difference.

I would say let the black man vote when he is fit to vote; prohibit the white man voting when he is unfit to vote. Especially would I appeal to the self respect of the colored race. I would inculcate in it the wish to improve itself as a distinct race, with a heredity, a set of traditions, an array of aspirations all its own. Out of such racial ambitions and pride will come natural segregation, without narrowing any rights, such as are proceeding in rural and urban communities now in Southern states, satisfying natural inclinations and adding notably to happiness and contentment.

On the other hand, I would insist upon equal educational opportunity for both. Educate every man to do his particular work whether it is manual labor or some higher plane. . . . Racial amalgamation there cannot be. Partnership of the races in

Harding's Birmingham Address

developing the highest aims of all humanity there must be if humanity, not only here but everywhere, is to achieve the ends which we have set for it.³³

The black man should seek to be, and he should be encouraged to be, the best possible black man and not the best possible imitation of a white man Our federal government is doing all in its power to bring about a readjustment in this period of reconstruction through which this country is passing. . . and we should all stand shoulder to shoulder for this purpose in the fellowship of states. . . . If the Civil War marked the beginnings of industrialism in the South which had previously been almost entirely agricultural, the World War brought us to a full recognition that the race problem is national rather than purely sectional. There are no authentic statistics, but it is common knowledge that the World War was marked by a great migration of colored people to the North and West. They were attracted by the demand for labor and the higher wages offered. It has brought the question of race closer to the North and West, and I believe it has served to modify somewhat the views of those sections on the question. It has made the South realize its industrial dependence on labor and the black man, and made the North realize the difficulties of the community in which two greatly differing races are brought to live side by side. I should say that it has been responsible for greater clarity on both sides, a beginning of better understanding and, in the light of that better understanding, perhaps we shall be able to consider this problem together as a problem of all sections, and of both races in whose solution the best intelligence of both must be enlisted.^{34, 35}

REACTION TO ADDRESS

As President Harding spoke to approximately 45,000 people, including 15,000 Negroes, who gathered in Wilson Park, there was immediate response. The Negroes cheered and roared applause, while the whites noticeably stiffened and stood silent when the President referred to (a) race problem since the World War, (b) South industrially dependent on black labor, (c) thousands of colored men fought in the war, (d) black vote when fit, prohibit white men when unfit, (e) equal education opportunity for both, (f) Negro be good black men rather than poor imitations of white men, (g) nation cannot go on successfully with one section shut off from national affairs by reason of its attitude on racial, political questions, and (h) whether you like it or not our democracy is a lie unless you stand for that equality. Both races applauded when he urged that social equality be eliminated from consideration.^{36, 37, 38, 39}

The religious ministers in Birmingham sent Harding a copy of a resolution they made the day after his address. The resolution sanctioned his efforts at world peace in the forthcoming Washington Conference but conspicuously failed to mention his address regarding the race problem. Also conspicuous by its absence was the failure of both

the Senate and the House of Representatives (Alabama) to mention the speech in a joint resolution sent to Harding October 27, 1921.⁴⁰

Governor Kilby, Alabama, approved Harding's speech.⁴¹ However, in Washington, Democrats considered him presumptuous in his inexperience to try and tell the South what to do about the Negro problem. Senator Harrison of Mississippi spoke against the speech, and Senator Watson of Georgia rebuked Governor Kilby for speaking in favor of Harding's speech. Senator Heflin of Alabama quoted Lincoln as having declared that the Negro was entitled to voting and jury privileges. "So far as the South is concerned," Heflin said, "we hold to the doctrine that God Almighty fixed the boundary between the two races and no Republican can improve upon his work." Four other Southern senators expressed similar views. Republicans declaring approval of the speech were Senator Calder, New York, Spencer of Missouri, and Willis of Ohio. They considered the speech "Lincolnesque, courageous, delivered as it was in the heart of the South." However, widespread comments indicated that Republicans considered Harding's choice of topic unfortunate.^{42,43,44,45}

W. E. B. DuBois, a prominent Northern Negro, claimed Harding's reference to "eternal difference" between the races "completely vitiated the more salutary aspects of his speech."⁴⁶ Robert R. Morton, who succeeded Booker T. Washington as President of Tuskegee Institute, spoke with enthusiasm of the speech, "Harding has expressed a statesmanlike viewpoint and has proposed a platform upon which blacks and whites can stand together. His speech is the most important utterance on this question by a President since Lincoln."⁴⁷ Two Negro organizations, Uplift Negroes, Washington, and People's Education Forum, New York, presented President Harding with resolutions for and against his speech, respectively.^{48,49}

There were widespread divergent expressions by editors of publications throughout the country. Both blacks and whites attacked and applauded Harding's speech as shown in Tables 1-4.

According to the literature cited in Tables 1-4, opinion for and against Harding's speech was almost equally divided. However, these were editorial expressions and the same newspapers, especially the Birmingham and Mobile newspapers (cited), printed numerous letters to the editor by individuals against Harding's speech, while only one such letter was located that favored the address. Those speaking against the speech were inflammatory, for example,

The Negro is inferior. He has an inferior brain. Migration to the North may be the means to solve the problem. The President should not have made the speech though it was masterful oratory. . . . If God intended for races to be equal, it will come about without oratory.⁷⁷

VIEWS RELATED TO BOOKER T. WASHINGTON'S

It was interesting to compare the adverse reaction to Harding's Birmingham Address with the acceptance of Booker T. Washington's views,

Harding's Birmingham Address

TABLE 1. Black publications favorable to Harding's address.

Publication	Excerpt of main point ⁵⁰
<i>LEDGER</i> (Indianapolis)	. . . Equality of opportunity is all that the negro asks, social equality is something that the negro race has never contended for.
<i>EAST TENNESSEE NEWS</i> (Knoxville)	. . . asked for square deal for colored people.
<i>JOURNAL AND GUIDE</i> (Norfolk)	. . . praise . . . South as a whole is not disposed to hold any deserving member of the negro race back, politically, economically, or educationally.
<i>FREE MAN</i> (Indianapolis)	. . . strive for the things that are obtainable.

TABLE 2. Black publications against Harding's address.

Publication	Excerpt of main point
<i>CHRONICLE</i> (Boston)	. . . an asinine attempt to help the Negro and not offend the South. ⁵¹
<i>NEGRO-AMERICAN</i> (Baltimore)	. . . discrimination at every point of contact between the two races. ⁵²
<i>THE CRISIS</i> (New York)	. . . dangerous and undemocratic. ⁵³
<i>NEW YORK CRUSADER</i>	. . . supports the worst negrophobist element of the South. ⁵⁴

which were almost exactly the same.

Booker T. Washington, founder and first President of Tuskegee Institute, died in 1915, six years prior to the Harding Address. "As a prominent Republican and as a spokesman of a philosophy so in harmony with the national temper, Washington gathered substantial power. He was financially supported by philanthropists and lauded by politicians."⁷⁸

Journal of the Alabama Academy of Science

TABLE 3. White publications favorable to Harding's address.

Publication	Excerpt of main point
<i>THE BIRMINGHAM NEWS</i>	. . . shoulder to shoulder with South, evidences sympathy and understanding. ⁵⁵
<i>BIRMINGHAM AGE HERALD</i>	. . . nothing new . . . no intention of pitting black against white . . . Southern hysteria ⁵⁶
<i>MOBILE PRESS REGISTER</i>	. . . praise President for giving speech in South ⁵⁷
<i>LOUISVILLE COURIER-JOURNAL</i>	. . . sound counsel ⁵⁸
<i>NEWS AND COURIER</i> (Charleston)	. . . impressive enunciation of truth ⁵⁹
<i>CONSTITUTION</i> (Atlanta)	. . . political equality . . . protection under the law for the Negro as a citizen ⁶⁰
<i>STAR</i> (St. Louis)	. . . approval . . . ⁶¹
<i>NEWS LEADER</i> (Richmond)	. . . approval of best public sentiment in South ⁶²
<i>TIMES</i> (Los Angeles)	. . . nation . . . aid South ⁶³
<i>HERALD</i> (New York)	. . . enunciated a new policy so far as the Republican party and the nation are concerned. ⁶⁴
<i>TIMES</i> (El Paso)	. . . right in pointing out problem for nation . . . courageous ⁶⁵
<i>SUN</i> (Baltimore)	. . . the South must meet his challenge ⁶⁶

Washington gave an address at the Atlanta Exposition in September, 1895 before thousands of people. This was the first time any Negro had made a speech in the South to an audience composed of white men and women. According to James Creelman in the *New York World*, "The fairest women of Georgia stood up and cheered . . . the sound dashed itself against the walls and the whole audience was on its feet in a delirium

Harding's Birmingham Address

TABLE 4. White publications against Harding's address.

Publication	Excerpt of main point
<i>ANDALUSIA STAR</i>	. . . does not understand problem as relates to South. ⁶⁷
<i>BIRMINGHAM POST</i>	. . . had only theory, not informed of actualities. ⁶⁸
<i>SELMA TIMES-JOURNAL</i>	. . . impolitic . . . done violence to the South's cherished tradition of white supremacy. ⁶⁹
<i>NASHVILLE BANNER</i>	. . . It irritates the South to be lectured on the alleged ill treatment of the Negro. ⁷⁰
<i>THE MEMPHIS COMMERCIAL</i>	. . . there is no race problem in the South. ⁷¹
<i>NEW ORLEANS TIMES-PICAYUNE</i>	. . . lending confusion to both sides. ⁷²
<i>NEWS</i> (Newark)	. . . retard progress by stimulating unnecessary and mischievous agitation. ⁷³
<i>NEWS</i> (Little Rock)	. . . make the ignorant and vicious of both races more ignorant and vicious. ⁷⁴
<i>JOURNAL</i> (Montgomery)	. . . the South resents intermeddling, whether that intermeddling comes from high or low. ⁷⁵
<i>VIRGINIAN POST</i> (Norfolk)	. . . it does not help much to be told. ⁷⁶

of applause!"⁷⁹

In his Atlanta Exposition Address Washington said:

The wisest among my race understand the agitation of questions of social equality is the extremest folly . . . in all things that are purely social we can be as separate as fingers, yet one as the hand on all things essential to mutual progress.⁸⁰

Some of Booker T. Washington's other views with which Harding's coincided were as follows: (Excerpts from Washington's speeches and published works.)

The Negro in this country constitutes the most compact, reliable and peaceful element of labor; one on which is almost sole dependence for production in certain directions. . . .⁸¹

The recent outbreaks by the mob emphasize . . . South and North, for it is to be noted that the work of the lyncher is not confined to one section of the country.⁸²

The Negro asks no special privileges. All that he asks is opportunity -- that the same law which is made by the white man and applied to one race be applied with equal certainty and exactness to the other.⁸³

Washington suggested a meeting of Northern white men and Southern white men and Negroes to consider solutions for the Negro problem. "When there is division on other great questions this method is followed, why not in this?" he asked.⁸⁴

The Negro has the right to study law and medicine . . . education must apply to the ordinary functions and activities of life, that which will link itself closely to every duty and responsibility of life.⁸⁵

There are some colored people . . . who would rather be classed as a third-rate white people than to be classed as first rate colored people . . . teach pride of race; teach the Negro girl or boy to be just as proud of being a Negro as a German, as an Irishman, and as a Frenchman are proud of being a member of their races.⁸⁶

I believe the permanent cure for our present evils will come through a property and educational test for voting that shall apply honestly to both races. This will cut off the large mass of ignorant voters of both races that is now proving so demoralizing a factor in the politics of Southern States.⁸⁷

The Negro must, in all hazard and in all times and places, avoid crossing the colour line . . . In freedom the security and happiness of each race depends, to a very large extent, on the education and progress of the other. The problem of slavery was to keep the Negro down; the problem of freedom is to raise him up. The Negro is simply . . . the man who is farthest down; as he raises himself up he raises every other man who is above him.⁸⁸

Whether Warren G. Harding adopted Washington's views or whether he gathered them from various sources and experiences, their views were similar. Harding not only voiced these views, he initiated action on them. His request for an interracial commission died in a congressional committee; his proposal for an antilynching bill died in a senate filibuster; his desire for an end to political and educational discrimination ran foul of national and sectional folkways. Even in the matter of patronage there were extenuating circumstances. In the area of race relations Harding deserved more credit than he received.⁸⁹

Harding's Birmingham Address

SUMMARY AND IMPLICATIONS

The data cited in this study seemed to indicate that in choosing the racial problem as the main topic of his address Harding was acting with the best interests of the nation in mind. If he had the best interests of the Republican party in mind that need not be an indictment. It may be that any one or all eight reasons set forth prompted him to speak as he did. Whatever prompted him, he was straightforward in his address and he spoke with conviction, as a matter of fact, with similar conviction on the same views that had been advocated years earlier by Booker T. Washington.

It appeared that Harding did the best that he could in his time and place to bring about better race relations. One cannot help but wonder what race relations would be like today in the United States if the nation, and the South in particular, had followed Harding's recommendations.

RECOMMENDATIONS

Assume that history teaches us "who we are." In that light, who are we relative to the present racial problems? Fifty years after Harding's Birmingham Address, do we accept his views? Do we act on them as individuals? In our individual every day living, do we promote equal educational, political, and economic opportunities for the Negroes whom we know personally? Or, do we just accept Harding's theory as a good one? One might answer, "Yes," to all the above questions and go further than Harding and say, "I believe in social equality of blacks and whites." In this case, how narrowly does one define "social equality" in his actions? Would this definition include blacks and whites visiting in each other's homes socially, dating, and intermarrying?

For many years people have been writing and talking about improving race relations. Some of these people tend to say one thing and do another. The only recommendation is: accept your responsibility for improving race relations and keep in mind the hackneyed but true expression, "Actions speak louder than words."

FOOTNOTES

¹News item in *The Birmingham News*, October 2, 1921, p. 1.

²News item in *The Birmingham News*, October 8, 1921, p. 20.

³News item in *The Birmingham News*, October 6, 1921, p. 14.

⁴News item in *The Birmingham News*, October 20, 1921, p. 1.

⁵News item in *The Birmingham News*, October 25, 1921, p. 1.

⁶Samuel H. Adams. *Incredible Era* (Boston: Houghton Mifflin Company, 1939), pp. 384-87, 490-97.

⁷Robert K Murray. *The Harding Era* (Minneapolis: University of Minnesota Press, 1969), p. 402.

⁸Joe Mitchell Chapple. *Life and Times of Warren G. Harding* (Boston: Chapple Publishing Company, 1924), pp. 1-10.

⁹_____. "President Harding Hesitates," *The New Republic*, XXIX (December 21, 1921), p. 91.

¹⁰Harry M. Daugherty. *The Inside Story of Warren G. Harding* (New York: The Church-hill Company, 1932), pp. 261-276.

¹¹Joe Mitchell Chapple. *Warren G. Harding - The Man* (Boston: Chapple Publishing Company, Limited, 1921), p. 112.

¹²Murray, *op. cit.*, p. 11.

¹³*Ibid.*, p. 400.

¹⁴Chapple, *Warren G. Harding - The Man*, *op. cit.*, p. 92.

¹⁵Murray, *op. cit.*, p. 536.

¹⁶*Ibid.*, p. 398.

¹⁷*Ibid.*, p. 401.

¹⁸Arthur F. Raper. *The Tragedy of Lynching* (Chapel Hill, North Carolina: University of North Carolina Press, 1933), p. 1.

¹⁹Southern Commission on the Study of Lynchings, *Lynchings and What They Mean* (Atlanta: The Commission, 1931), p. 73.

²⁰*Ibid.*, p. 61-73.

²¹Murray, *op. cit.*, p. 376.

²²*Ibid.*, p. 401.

²³*Ibid.*, pp. 398-400.

²⁴_____. "President Harding Discourses on the Color Line," *Current Opinion*, LXXI (December, 1921), p. 705.

²⁵*Ibid.*

²⁶News item in *The Birmingham Age-Herald*, October 28, 1921, p. 1.

²⁷*Ibid.*

²⁸News item in *The Birmingham News*, November 2, 1921, p. 1.

²⁹News item in *The Birmingham News*, October 26, 1921, p. 1.

Harding's Birmingham Address

³⁰*Current Opinion*, *loc. cit.*

³¹_____. "The Negro's Status Declared by the President," *The Literary Digest*, XXI (November 19, 1921), p. 8.

³²*Current Opinion*, *loc. cit.*

³³*Ibid.*, pp. 705-07.

³⁴*The Birmingham News*, October 26, 1921, *loc. cit.*

³⁵News item in *Dothan Weekly Eagle*, October 28, 1921, p. 1.

³⁶*The Birmingham News*, October 26, 1921, *loc. cit.*

³⁷News item in *The Birmingham News*, October 27, 1921, p. 1.

³⁸News item in *The Mobile Press Register*, October 27, 1921, p. 1.

³⁹News item in *The New York Times*, October 27, 1921, p. 1.

⁴⁰*The Birmingham News*, October 27, 1921, *op. cit.*, p. 24.

⁴¹*The Birmingham News*, October 26, 1921, *loc. cit.*

⁴²News item in *The Birmingham Age-Herald*, October 27, 1921, p. 1.

⁴³*New York Times*, *op. cit.*, p. 4.

⁴⁴*Current Opinion*, *op. cit.*, p. 708.

⁴⁵Murray, *op. cit.*, p. 400.

⁴⁶*Ibid.*

⁴⁷*Current Opinion*, *op. cit.*, p. 707.

⁴⁸*Ibid.*

⁴⁹*The Birmingham Age-Herald*, *loc. cit.*

⁵⁰*The Literary Digest*, *op. cit.*, p. 9.

⁵¹*Current Opinion*, *loc. cit.*

⁵²*Literary Digest*, *loc. cit.*

⁵³*Ibid.*

⁵⁴*Ibid.*

⁵⁵Editorial in *The Birmingham News*, November 4, 1921, p. 6.

⁵⁶Editorial in *The Birmingham Age-Herald*, October 29, 1921, p. 6.

- ⁵⁷Editorial in the *Mobile Press Register*, October 28, 1921, p. 6.
- ⁵⁸*Ibid.*, ed. reprint.
- ⁵⁹Editorial in *News and Courier*, October 27, 1921, p. 4.
- ⁶⁰*Current Opinion*, *op. cit.*, p. 708.
- ⁶¹*Ibid.*
- ⁶²*Ibid.*
- ⁶³*Literary Digest*, *op. cit.*, p. 1.
- ⁶⁴*Ibid.*
- ⁶⁵*Ibid.*, p. 9.
- ⁶⁶*Ibid.*
- ⁶⁷Editorial reprint in *The Birmingham News*, November 2, 1921, p. 1.
- ⁶⁸Editorial in *The Birmingham Age-Herald*, October 30, 1921, p. 12.
- ⁶⁹Editorial reprint in the *Mobile Press Register*, October 30, 1921, p. 6.
- ⁷⁰*Ibid.*
- ⁷¹*Ibid.*
- ⁷²*Ibid.*
- ⁷³*Current Opinion*, *op. cit.*, p. 705.
- ⁷⁴*The Literary Digest*, *op. cit.*, p. 8.
- ⁷⁵*Ibid.*
- ⁷⁶*Ibid.*
- ⁷⁷Editorial in *The Birmingham News*, November 3, 1921, p. 9.
- ⁷⁸Thomas Gilliam. *Aspects of the Philosophies of Booker T. Washington and W. E. B. DuBois* (Paper for Hugh Reagan, Auburn University), May 18, 1967, p. 9. (Typed).
- ⁷⁹Booker T. Washington. *Up from Slavery* (New York: Doubleday and Company, 1905), p. 238.
- ⁸⁰E. Davidson Washington (ed.). *Selected Speeches of Booker T. Washington* (New York: Doubleday, Doran, and Company, Inc., 1932), p. 34.
- ⁸¹*Ibid.*, p. 97.

Harding's Birmingham Address

⁸²*Ibid.*, p. 95.

⁸³*Ibid.*, p. 113.

⁸⁴*Ibid.*, p. 115.

⁸⁵*Ibid.*, p. 202.

⁸⁶*Ibid.*, p. 205.

⁸⁷Booker T. Washington, *The Future of the American Negro* (Boston: Maynard and Company, 1899), p. 153.

⁸⁸Booker T. Washington, *The Story of the Negro* (New York: Peter Smith, 1940), pp. 393, 399.

⁸⁹Murray, *op. cit.*, p. 402.





(76, 1) \$

THE JOURNAL

OF THE

ALABAMA ACADEMY
OF SCIENCE,

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830

LIBRARY

VOLUME 43

APRIL, 1972

NUMBER 2

AUG 24 1973

THE AMERICAN INSTITUTE



THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

**AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE**

VOLUME 43

APRIL, 1972

NUMBER 2

EDITOR
Elroy A. Curl
Auburn University

ARCHIVIST
Clyde H. Cantrell
Auburn University

E D I T O R I A L B O A R D

Lowell Wilson, Chairman
Auburn University

Elroy Curl
Auburn University

Ann Everett
Plainview High School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ARTICLES

Privacy and the United States Census H. Ellsworth Steele	80
A Nomograph for Testing Proportions when Normal Approximations Are Appropriate Glenn H. Gilbreath and Joseph G. Van Matre	91
Framing Confederation Land Policy: The Role of the Massachusetts Delegation John R. McCreary	94
Compost — The Unorthodox Way for Organic Gardeners Emmett B. Carmichael	107
The German Working Class Movement and The Austro-Prussian War of 1866 William H. Maehl	111
Blast Furnace Operations with the Use of the Warrior Basin and Blue Creek Basin Strip Mine Coals in Metallurgical Coke Robert E. Cooper and Leonard G. Allen	122
Environmental Land-Use Applications from Space Research Charles T. N. Paludan	125
Do Consumers Know Anything? E. H. Bonfield and Samuel H. Himes, Jr.	142
Solid Waste Collection Problems Richard M. Wyskida	146

Privacy and the Census

PRIVACY AND THE UNITED STATES CENSUS

H. Ellsworth Steele
Department of Economics and Geography
Auburn University, Auburn, Alabama

We all cherish our privacy. The right to decide what part of our feelings and thoughts, what facts of our personal life to share with others is essential to our dignity and to our freedom of self-determination.¹ As Ramsey Clark, former United States Attorney General, declares, "Privacy is the basis of individuality. To be alone and be let alone, to be with chosen company, to say what you think or don't think, but to say what you will, is to be yourself. . . . To penetrate the last refuge of the individual, the precious little privacy that remains, the basis of individual dignity, can have meaning to the quality of our lives that we cannot foresee."²

Today many Americans feel that their privacy is being threatened. The affluent fear the computer which "neither forgives nor forgets." Low income whites and blacks are apprehensive of credit investigations. Young people in rural areas, especially, are concerned lest others listen in on their telephone conversations. Public opinion poll-takers and social security forms worry others. And to many people, the decennial census is an invasion of privacy.³

To these people, the census is an integral part of an insidious and expanding attack on their "right to be let alone." In their view, employment application forms, psychological tests, insurance company records, credit company practices, welfare investigations, income tax reports, congressional investigations, the Internal Revenue Service's system of exchanging tax data with 25 states, the data network of the National Crime Information Center which reaches 48 states and most large cities, the six million files on "revolutionary activities" maintained by the American Security Council, wiretapping by the FBI, army dossiers, the emerging possibilities of electronic surveillance, and the census too--all pose threats to the privacy of the American Citizen.⁴

"THE CENSUS INQUISITION"

Challenges to the U.S. census are not new. Senator Charles W. Tobey's attack on census plans in a radio broadcast in 1940 struck fire in scattered areas across the country.⁵ That response, however, did not compare to the alarm over the census which swept the nation in 1969 and 1970 and may again as 1980 approaches.

Stimulated by congressional leaders, especially Rep. Jackson E. Betts, Republican of Ohio, a shrill chorus of criticism was directed against the census and the Census Bureau. The *Chicago American* declared that the 1970 census raised the issue of "How far a government may be allowed to override its citizens' reasonable desire for privacy. The theory behind this long census questionnaire and the legal penalties backing it up appears to be this: 'We want this information for our own good reasons, so you cooperate or else.'" The *Tribune*, in an editorial entitled "Answer or be Jailed," accused Census Director A. Ross Eckler of planning to use

"super-snooping census techniques."⁶ The *Daily Oklahoman* assailed "Federal Invasions of Privacy" contrasting the Supreme Court's "solicitous concern for the privacy of criminal defendants with the federal government's contemplated wholesale invasions of the privacy of law-abiding citizens in next year's decennial census."⁷ Joining the chorus, but in lower key, the *Wall Street Journal* asserted that, "The point of proposals to limit mandatory census questions is not that the questions asked so far have been especially odious. Rather, the point is that at present there is absolutely no review of the questions the Census Bureau decides to ask."⁸

The attack on the census took two forms. In Congress a series of 69 bills were introduced calling for drastic revisions. Across the country, a campaign of criticism was launched, urging noncooperation.

The census and the Bureau, however, were not without their defenders. The *Orlando Sentinel* declared that the emotionalism generated by the heated debates over the census "has been caused by distortions and exaggerated the census questions prepared for next year."⁹ Dr. Kingsley Davis, sociologist from Berkeley, asserted that the privacy issue was "a false issue". . . "taken up because it is a convenient, ambiguous and emotional complaint likely to have a wide appeal and therefore handy for a variety of people who have a grudge against the Government."¹⁰

Maurice H. Stans, who as Secretary of Commerce is legally responsible for the census, vigorously rejected allegations of invasion of privacy. Such claims, he argued, must be mistaken because the census never publishes lists of people or information on individuals; never has been accused of disclosing anyone's report; follows rigid procedures to avoid releasing details that would permit identification; carefully evaluates its questions, procedures, and results; and has performed its duties with the highest respect for public rights.¹¹

Planners of all varieties rallied to the support of the census. Economist St. Clair Tweedie agreed that the "indignations and fears" concerning invasion of privacy "are real and justified, but the target of this sentiment is the wrong one."¹² Glenn Kumekawa, President of the New England Chapter of the American Institute of Planners, opposed great changes in the census, asserting that the "U.S. Census without the social and economic data thereto would be a major calamity in terms of the planning profession and the number of other federal programs with which planning agencies have to deal."¹³ Georgia planner, Thomas A. Conger, pleaded, ". . . the U.S. Census is to us planners as sacred as God, mother, country, and apple pie. Save the U.S. Census."¹⁴ Rep. Arnold Olsen of Montana summed up the views of many, stating, ". . . the critics of the Census Bureau have the saddle on the wrong horse."¹⁵

REFORMING THE CENSUS

Defeated in his attempt to make fundamental changes in the census in 1967, Rep. Betts returned to the fray in 1969. He found four major issues involved in the census. First, the questions included had to be answered subject to a penalty. Second, some questions were non-essential. Third, the census infringed on privacy through extensive public interrogations, and fourth, the census competed with private research firms and

Privacy and the Census

non-profit institutions. To correct these evils, he proposed to make all but seven key questions voluntary. His bill drew the support of 151 other congressmen.¹⁶

Technical critics charged that the Bureau's "disclosure suppression routines" when releasing data for small areas or conducting matching studies were not adequate to protect privacy. Furthermore, by use of the area coding guide, reverse telephone directories and census tract data, interested persons could locate concentrations of individuals with given characteristics such as age, race, marital status, number of children and income. With this information, firms could then "skim the cream" of likely prospects, pinpoint areas of high risk, and raise insurance and other rates, or, by adding automobile registration and telephone data, simulate "personalized" mail to prospects with high potential.¹⁷

AN APPRAISAL OF THE CENSUS AND OF THE BUREAU

As 1980 nears, we may again anticipate a wave of criticism of the census for public concern over invasions of privacy continues to fill the media. An objective evaluation of the issues raised by the census and by Bureau procedures would contribute a needed perspective to such a debate. The beginnings of such an appraisal will be attempted here.

Confidentiality

The Bureau enforces strict measures to ensure confidentiality. All employees take an oath of confidentiality subject to severe penalties. When the census forms reach the Bureau, the data from them, excluding the names, addresses and telephone numbers, are placed on tapes for computer processing. Thus, the data used "are wholly impersonal and unidentifiable."¹⁸ The original returns are microfilmed and destroyed. The microfilm is stored in a "search office" in Pittsburg, Kansas, so that citizens under careful restrictions may secure from their own returns data needed to prove their age for passport, social security, or other purposes. The Bureau is keenly aware of the dangers of indirect disclosure and has developed procedures to detect these possibilities and to avoid them. As a result, census publications carry many cells with no data because the information has been suppressed to avoid disclosure.¹⁹

The Internal Revenue Service and the Social Security Administration may be required by law to present evidence from their records in court, but the courts cannot direct the Census Bureau to reveal individual information. As the census forms assure respondents, the answers given cannot be disclosed to anyone outside the Bureau for any reason. The Bureau's adamant position in conforming to this law has been upheld repeatedly in the courts.²⁰

As Rep. Cornelius E. Gallagher, one of the more perceptive advocates of privacy has brought out, the Bureau's position on the confidentiality of its records was subjected to a severe test after Pearl Harbor, but, "The Bureau of the Census did not succumb to the prevailing mood of hysteria. The Bureau resisted pressures to make known to other branches of the executive the names and addresses of every Japanese-American citizen of the United States."²¹

Burden of answering

Critics claimed that not only was the 1970 census an invasion of privacy, but it added insult to injury by making "utterly ruthless demands on the time of every person questioned."²² Furthermore the number of questions was burgeoning.

In fact, the 1970 census did include seven new questions. The exact number of questions asked is difficult to state. Three basic forms were used. One form carried questions answered by all. A second carried additional questions for every fourth respondent and the third, additional questions for every twentieth respondent. Many questions presented multiple choices to respondents. Furthermore, housing questions had to be answered only once for each household and personal questions only once per person. The maximum number of questions any head of household had to answer appears to have been 89.²³

On the basis of the use of sampling and excluded alternatives, Assistant Secretary of Commerce William H. Chartener concluded that ". . .the average number of questions asked per household in the 1970 census will be the smallest in 100 years." The 1890 census, for instance, had contained 470 items.²⁴ According to census field tests, the short form took about 15 minutes and the long forms about 45 minutes to complete. This fact, understandably, led the census defenders to ask, "Is this an unreasonable request for the Government to make of its citizens once every ten years?"²⁵

Selection of questions

The inclusion of a question in the census is hardly the result of bureaucratic caprice. Each question must survive vigorous competition from others which users of statistics would like to have included. In making its selections of items, developing its wording, and establishing its procedures, the Census Bureau makes extensive use of outside advice.

Beginning in 1902, the Bureau has drawn upon the assistance of advisory committees of knowledgeable users of census statistics. The oldest committee includes representatives from the American Statistical and the American Economic Associations. The Bureau is advised also by the Conference of Population and Housing Census Data Users, the Housing Advisory Committee, and the Census Advisory Committee on Population Statistics. Also in continual touch with the Bureau is the Federal Statistics Users Conference, which comprises 170 business, labor and non-profit organizations and corporations. To improve communications between the Bureau and federal users of census data, the Bureau of the Budget in 1965 established the Federal Council on the 1970 Census, which brought together approximately 40 agencies. Finally, the Bureau remains in close consultation with the Subcommittee on Census and Statistics of the House Committee on Post Office and Civil Service.

In developing the questions and procedures for 1970, the Bureau not only consulted with these groups, but held meetings in more than 22 cities across the nation to which over 2,000 persons representing many organizations came. In addition, staff members conferred with representatives of 88 national organizations who were invited to discuss census plans with them.²⁶

Privacy and the Census

To guide its selection of questions for 1970, the Bureau established these standards: Questions must be of "broad public interest;" must be needed for small areas; must be answerable in an "unambiguous and reliable way;" must be generally acceptable by the public "as relevant to the census;" must not involve an undue burden on the respondents; and the cost of collection must be within the resources available.²⁷

This review process winnowed out many questions vigorously championed by government agencies and others desiring more and better data to implement their own programs. A good example was a question on the nature of disabilities requested by vocational rehabilitation officials which was rejected as "too sensitive." To learn public reaction to the questions tentatively selected and to test its procedures, the Bureau ran 20 test censuses.

Some critics found this lengthy procedure biased in favor of users and neglectful of the interests of those who give the data. They would have Congress give final approval for each question. This indeed was the situation until 1930. While Congress was directly in charge of developing the questions, the list included such items as, "Is there anyone living here who is insane or idiotic?" "Is this person restrained by a strap, strait jacket, etc.?" Concerning idiots, Congress's questions went on, "Is this person self-supporting?" "What is the size of his head (large, small, or natural)?" "Has the origin of this child been respectable?"²⁸ Many other similar illustrations can be cited.

While it is doubtful that Congress today would ask such questions as these, the record does not suggest that giving Congress final approval of specific questions would produce questions less apt to unduly invade privacy than the procedures which the Bureau has evolved under Congress's broad supervision.

Questions benefiting special interests

The Manassas Journal Messenger and other critics complained that through the census, ". . .the government has become a free market polling service for all sorts of private interests which have no right to have their business conducted for them at taxpayers' expense--and at citizen's discomfort."²⁹

This charge was well answered by John H. Aiken, of the Federal Statistics Users Conference, who stated, "Census data provide a foundation for the making of many vital economic and policy decisions by private enterprise that have an impact on the total economy and thereby affect the general welfare. The myriad of decisions made daily affect the level and direction of change in our economy. It is in the public and national interest that the information upon which these decisions are based be adequate, reliable and complete." Furthermore, just because businesses do benefit from census data is no reason to deprive all other users of vital information.³⁰

Although a few private research organizations see the census as a government effort to "muscle in" on their preserves, most recognize that

they cannot hope to compete with the census in developing standardized, comparable and reliable data for the country as a whole. Indeed, they look to the census to provide the starting point for their own efforts.

Questions on plumbing

Critics had a field day asking whether a housewife should be jailed for refusing to answer whether she shared her bathtub or shower with other householders. To detonate this criticism, based on a distorted interpretation of questions that had been included in the census for many years, Secretary of Commerce Stans changed the phrase "shared with another household" in the questions concerning bathtubs, showers and toilets to "also used by another household," and thus ensured continuance of some of the best available indicators of housing quality.³¹

Question on number of babies born

The sharpest controversy focused on the question posed to women, "How many babies has she ever had, not counting stillbirths," Rep. Gallagher called the question a "virtual celebration of insensitivity" that could not "help but put many people in an extremely embarrassing position within the family group."³²

The question has been on all census schedules since 1890 except those for 1920 and 1930. Census officials insisted that test censuses conducted in 1969 revealed no reluctance to answer; they also noted that the use of mail questionnaires in metropolitan areas in which 60 percent of the people live would help to reduce embarrassment. Planners and health officials argued vigorously for the question, saying that "babies are born to unwed mothers. . .and we shouldn't play ostrich." They contended that the data on completed family size are important for studies of the causes of infant and maternal mortality and of certain defects of childhood and are needed in making plans for schools and for such programs as aid to families with dependent children and maternal and child health centers.³³

Questions on race and ethnic origin

As might be expected, census plans to ask about race and ethnic origin drew criticism. The American Civil Liberties Union had opposed questions on race in 1960, but by 1970, had decided that they could be asked, but only on a voluntary basis.³⁴ The U. S. Commission on Civil Rights, however, wanted the questions to be mandatory because it had concluded that "the lack of adequate census information had harmed the best interests of minority population groups" and only mandatory questions would yield accurate data. Dr. Joseph E. Cannon of the Rhode Island Department of Health also championed mandatory answers. He urged persuasively that such data are needed in planning public and private medication programs "to detect, prevent, treat and eradicate diseases differentially affecting large minority groups." He felt that lack of these data would "hamper efforts to determine what factors are inherent within the race, or may be the result of influences such as income, property ownership, availability of health programs and so on."³⁵

Privacy and the Census

While criticism was being directed against questions concerning race, persons of Spanish heritage were asking separate identification. Spokesmen noted that they were a people "of growing self-awareness" and declared that failure to take a direct ethnic count would be discrimination and amount to "demographic euthanasia of our people." They argued that the government cannot respond intelligently to the problems of Mexicans and Mexican-Americans, for instance, "if it has no idea how many there are, who they are, and where they are."³⁶ As a result of their pleas, sympathetically received by the Subcommittee on the Census and Statistics, the census schedule for one person in twenty asked individuals to indicate if their "origin or descent" were "Mexican, Puerto Rican, Cuban, Central or South American, Other Spanish or none of these."

Mandatory answers

The major thrust of Rep. Betts' proposals was to make the answers to most questions voluntary. His argument was that mandatory questions are an especial invasion of privacy and reduce cooperation. In support of his position, some critics declared, ". . . traitors, murderers and criminals of all categories can refuse to answer under the protection of the fifth amendment but anyone refusing to answer the census questions has no recourse." Liberal questioners of the census saw it as particularly threatening to blacks, the poor and the unskilled, and others found it "hard to justify" compelling answers to questions about the number of radios, cars, bathrooms and bedrooms.³⁷

Defenders of the census pointed out that making the questions voluntary would probably reduce response. They felt that many enumerators would be tempted not to follow up to secure answers to voluntary questions. Respondents might conclude that the mandatory questions had to be answered, but the others should be skipped. On the other hand, eager enumerators determined to secure responses to voluntary questions might be viewed as harrasing respondents. The result of making questions voluntary would be that especially among the ghetto dwellers--the blacks and low income whites who are already suspicious of the "establishment"--response would be low. And it is just these groups which stand to gain most by full and accurate census counts to reveal their needs and to guide government programs.

Although penalties for refusal to answer census questions are rarely used--apparently no one has ever been sent to jail and only two persons were fined in 1960 for ostentatiously refusing to answer census questions--the existence of the penalties makes mandatory questions "creditable." Census officials and other researchers believe that the presence of penalties "opens many doors" which otherwise might remain closed. Furthermore the mandatory questions assure each citizen that his government needs his help in completing the census and tells him that the census will not be a success without the information he gives. Abolishing the penalties would only reward the uncooperative and penalize the cooperative citizen who takes his time to answer and suffers whatever invasion of privacy that is involved.

The argument that private organizations and the Census Bureau itself in smaller surveys successfully use a voluntary approach, therefore the

decennial census should be voluntary, does not withstand close scrutiny. In these small surveys, highly trained personnel, intensive interviews and careful follow up can be utilized. In using 180,000 persons swiftly recruited and trained to count more than 200 million people within a short period, the Census Bureau has neither the time nor the money to follow such an approach.

Furthermore, the census must achieve the higher level of response which its mandatory approach permits. The significant level of non-response which voluntary questions produce introduces undetermined biases into results. Researchers agree that people who answer voluntary surveys differ in important but indeterminant respects from those who refuse to answer. Such self-selection of respondents would endanger the quality of the census, especially for small areas. Information gathered in such unstructured samples would not be sufficiently reliable to use in making estimates to guide successful programs of action.

Ironically, the very same voluntary private and public surveys which critics would have replace much of what the decennial census does are often made possible by the complete enumerations made in the census. Census data provide the essential benchmarks which other researchers can use to construct their own samples and to test their results.

If the scope of the census were severely restricted and special local surveys were relied upon to fill the void, the result would verge on statistical chaos. Respondents would find their privacy invaded by numerous interviewers, not all bound by the strict professional standards of the Census Bureau. Of necessity these fragmentary surveys would fall short of the standardization, comparability, reliability, and availability which are hallmarks of the Bureau's work. And of major importance, the data gathered in scattered and uncoordinated surveys could not produce the vital cross-classification analyses which make the nation-wide census so extremely valuable.³⁸

Sample discrimination

Some opponents of the census procedures insist that by using mandatory questions in sample surveys the census unfairly exposes those drawn in the random samples to extra risks of penalties for refusing to answer. As one man objected, "I do not want to play Russian Roulette of my own free will, and I object to having the game forced on me. . ."³⁹

Obviously, the sampling approach does involve chance exposure to the penalties for refusal. But the procedure does reduce the burden imposed on potential respondents as a total group and thus minimizes necessary invasions of privacy. The method has been used in each census from 1940 and has been upheld in the courts.⁴⁰

IN THE SCALES: PRIVATE RIGHTS AND PUBLIC NEEDS

The idea that we can maintain our privacy without any invasions is utopian. But the charges that the Census Bureau in conducting the decennial census is significantly and avoidably endangering the individual privacy of American citizens seem to be "sadly unsubstantiated."⁴¹ Indeed

Privacy and the Census

the "show of false righteousness over privacy rights" made by many of these critics, jeopardized a major basis for effective community planning in 1970 and may again in 1980 if the census is not viewed in proper perspective.⁴²

Government of the people, by the people and for the people, is a two-way street over which obligations must flow to the government as well as from the government. As census officials concede, nearly all the questions may be of embarrassment to some individuals, but the need of the government for the information must be balanced against the impact which giving it may have upon those affected. We must yield some of our individual rights for the good of the community if our nation is to survive and prosper. As our society grows more and more complex, the interests of the individual require that governments and other organizations gather more information so that they may function with greater efficiency and sensitivity. Responding to the census questions is one of the least onerous obligations of citizenship. In answering, each of us is actually assisting in planning programs for ourselves with a minimum of effort.

Continued vigilance needs to be exercised by the Census Bureau, the Congress in supervising the Bureau, and citizens in evaluating the actions of both lest the Census Bureau, despite its fine record, should relax and unduly invade individual privacy. But making the census and the Bureau scapegoats in an emotional and unobjective attack on governmental agencies can be dangerous if it diverts the attention of society from real invasions of privacy and if it should deprive government, non-profit, and profit-making organizations of data vital to the operation of our economy and to the solution of our economic and social problems.

FOOTNOTES

¹Phil Hirsch, "The World's Biggest Data Bank," *Datamation*, (May, 1970), p. 71, quoting the President's Office of Science and Technology.

²Ramsey Clark, *Crime In America* (New York: Simon and Schuster, 1970), p. 287.

³U.S., *Congressional Record*, 91st Cong., 2nd Sess., August 5, 1970, E 7354-55, quoting a Louis Harris poll.

⁴*Ibid.*, pp. E 7351-54, quoting *Newsweek* cover story of July 27, 1970 entitled "The Assault on Privacy."

⁵U.S. Congress, House, Committee on Post Office and Civil Service, *Confidentiality of Census Information*, 91st Cong., 1st Sess., 1969, p. 5 quoting Ann Herbert Scott from *Census U.S.A.*

⁶U.S. Congress, House, Subcommittee on Census and Statistics of the Committee on Post Office and Civil Service, *Part I, 1970 Census and Legislation Related Thereto*, 91st Cong., 1st Sess., 1969, p. 139 quoting the *Chicago American* of March 13, 1969. (Hereafter referred to as *Part I.*)

⁷March 27, 1969, quoted, *ibid.*, p. 162.

⁸April 7, 1969, quoted, *ibid.*, p. 171.

⁹April 6, 1969, quoted, *ibid.*, p. 178.

¹⁰U.S. Congress, House, Subcommittee on Census and Statistics of the Committee on Post Office and Civil Service, *Part II, 1970 Census and Legislation Related Thereto*, 91st Cong., 1st Sess., 1969, p. 542 (Hereafter referred to as *Part II.*)

¹¹*Part I*, p. 264. Most census schedules completed before 1900 have been placed in the National Archives. Some have been deposited with state historical societies and other state agencies. These forms are open for public inspection. Schedules collected in 1900 and thereafter are not open for inspection. Letter of April 14, 1971 from Conrad Taeuber, Associate Director, Bureau of the Census.

¹²*Part II*, p. 599.

¹³*Ibid.*, p. 629.

¹⁴U.S. Congress, House, Subcommittee on Census and Statistics of the Committee on Post Office and Civil Service, *Part III, 1970 Census and Legislation Related Thereto*, 91st Cong., 1st Sess., 1969, p. 655. (Hereafter referred to as *Part III.*)

¹⁵U.S. Congress, House, Subcommittee on Census and Statistics of the Committee on Post Office and Civil Service, *Limit Categories of Questions in Decennial Censuses*, 90th Cong., 1st Sess., 1967, p. 75. (Hereafter referred to as *Limit.*)

¹⁶Sidney L. Welch, "Planning the 1970 Decennial Census Questions: An Exercise in Bias," quoted in *Part III*, p. 790.

¹⁷Hirsch, p. 68 and Lance J. Hoffman and W. F. Miller, "Getting a Personal Dossier from a Statistical Data Bank," *Datamation*, (May, 1970), p. 74.

¹⁸Rep. Arnold Olsen, Montana, *Limit*, p. 75.

¹⁹*Part I*, p. 47 and letter of March 26, 1971 from Conrad Taeuber.

²⁰*Ibid.*, p. 16.

²¹*Ibid.*, p. 210.

²²Dr. Mollie Ray Carroll, economist and sociologist from Virginia, *Part II*, p. 614.

²³*Part I*, p. 44.

²⁴*Ibid.*, pp. 386 and 422.

²⁵*Limit*, p. 73.

- ²⁶Welch in *Part III*, pp. 787-88 and A. Ross Eckler, Director of the Census Bureau in *Part I*, pp. 13-14.
- ²⁷*Part I*, p. 385.
- ²⁸Rep. Olsen, *Limit*, pp. 70-71.
- ²⁹Editorial of May 15, 1969 quoted in *Part II*, p. 589.
- ³⁰*Limit*, p. 66 and Frank Hardinge, Jr., Executive Vice President, California Savings and Loan League, Pasadena, California, *Part II*, p. 465.
- ³¹John C. Baker, "The Census Combated its Opposition with a Low Profile," *Patomac*, *Washington Post*, November 22, 1970, p. 13.
- ³²*Part I.*, p. 213.
- ³³Donald I. Foley, Professor of City and Regional Planning, Berkeley, *Part II*, p. 538; Dr. Lester Breslow, Professor of Health Services Administration, UCLA, *Ibid.*, p. 492; and Lester H. Butler, Assistant Secretary for Planning and Evaluation, HEW, *Part I*, pp. 364-65.
- ³⁴*Part I*, pp. 54-55.
- ³⁵*Part I*, p. 376 and *Part II*, p. 626.
- ³⁶*Ibid.*, pp. 519-21 and 482-84.
- ³⁷*Part II*, p. 519 and *Part I*, p. 124.
- ³⁸William G. Roberts, Sectional Director, Southeast Chapter, South Carolina Section, American Institute of Planners, *Limit*, p. 118; Glenn O. Johnson, Chief, Systems and Data Services Division, Los Angeles City Planning Department, *Part II*, p. 439; and Rep. Olsen, *Limit*, p. 75.
- ³⁹*Part II*, p. 589.
- ⁴⁰*Part I*, p. 284.
- ⁴¹Irvin G. Franzen, Director of the Division of Vital Statistics, Kansas Department of Health, *Limit*, p. 90.
- ⁴²*Part II*, p. 627, quoting *Providence Journal*, May 11, 1969.

A NOMOGRAPH FOR TESTING PROPORTIONS WHEN NORMAL
APPROXIMATIONS ARE APPROPRIATE

Glenn H. Gilbreath
Virginia Commonwealth University
and

Joseph G. Van Matre
University of Alabama, Birmingham

Many problems in applied statistics arise in which one is required to perform tests of hypotheses concerning parameters of the binomial distribution. Such problems occur frequently in such areas as industrial engineering, psychology, and education. Under certain conditions, the normal distribution provides a sufficiently accurate approximation to the probability of X successes in a sequence of n Bernoulli trials. Similarly, the sampling distribution of p , the sample proportion, is known to approach normality as n increases with mean Π , the population proportion, and standard deviation $\sigma_p = \sqrt{\Pi(1-\Pi)/n}$. This relationship is frequently exploited in testing hypotheses about population proportions.

An early aid to practitioners was the well-known chart developed by Clopper and Pearson (1) for obtaining confidence limits for a proportion; here one must consult a different chart for each different confidence coefficient. More recently, Larson (3) introduced a nomograph which can be used for obtaining confidence limits, performing significance tests for either a population proportion or for the difference between two observed sample proportions, and designing control charts. The less complex nomograph to be presented here is designed explicitly for either a one- or two-tailed test of a population proportion Π . The simplicity serves to increase rapidity of the test and to better illustrate underlying relationships.

Consider the test of $H_0: \Pi = \Pi_0$ versus $H_1: \Pi \neq \Pi_0$. A rule of thumb frequently given is that if $n\Pi > 5$ and $n(1-\Pi) > 5$, then the normal approximation is appropriate (2). Assume these conditions are met. This hypothesis is tested by computing $\sigma_p = \sqrt{\Pi_0(1-\Pi_0)/n}$ and the standard normal deviate, $Z = (p-\Pi_0)/\sigma_p$. H_0 is or is not rejected by comparing the computed value of Z with a tabular value of Z for some desired level of significance, α .

Let us define a critical difference of $(p-\Pi)$ as being the value such that, if an observed value of $(p-\Pi)$ exceeds the critical difference, the null hypothesis is rejected. Since this difference can be positive or negative, we shall deal with the absolute value, $|p-\Pi|$. The critical value is, of course, dependent upon the population proportion, sample size, and level of significance. Graphical presentation of the n , Π , α , and $|p-\Pi|$ relationships in the form of a nomograph should prove advantageous.

A nomograph for testing hypotheses concerning proportions is given in Figure 1. The nomograph can be employed when the normal approximation is appropriate. The series of curves in the upper half of Figure 1 is based on the observation that, once n is specified, the standard error of the proportion is entirely dependent on the value of the population proportion, Π . The lower half of the nomograph was constructed by

Nomograph for Testing Proportions

recognizing that, once α is specified, the critical value of $|p-\Pi|$ is dependent on only the value of the standard error. Hence, given Π , n , and α , the nomograph yields the critical value of $|p-\Pi|$. Various levels of n and α are presented.

The procedure then is to reject H_0 if the observed difference is greater than the value of $|p-\Pi|$ on the nomograph for the given n , p , α , and hypothesized Π ; otherwise, H_0 is not rejected. For a single-tail test, double the level of significance.

Although the scale of Π runs from 0 to 0.5, the nomograph can still be used to test hypotheses when $\Pi > 0.5$ by simply rephrasing the problem in terms of $(1-\Pi)$.

Example

A sample where $n = 100$, $p = 0.15$ is used to test $H_0: \Pi = 0.2$ versus $H_1: \Pi \neq 0.2$ at $\alpha = 0.05$. Enter the upper half of Figure 1 on the right hand side with $\Pi = 0.20$. Using a straight edge, align horizontally until the sample size $n = 100$ is reached. Read vertically from this point to the level of significance $\alpha = 0.05$. Read across horizontally to find $|p-\Pi| = 0.0780$, the critical difference. The observed $|p-\Pi| = |0.15 - 0.20| = 0.05$. Therefore, H_0 is not rejected. (Note that in reading downward one obtains σ_p , the standard error, on the horizontal axis. In this example $\sigma_p = 0.040$.)

This tool provides a rapid determination of whether an observed value of $|p-\Pi|$ is significant. The graphic illustration of the various relationships is also enlightening. The accuracy of the nomograph depends upon the accuracy of the normal approximation to the binomial, which increases as n increases and as Π approaches 0.5. The discontinuity of the curves in Figure 1 reflects the fact that the approximation should not be employed when $n\Pi < 5$. When this is true, a table of the cumulative binomial distribution (4) can be consulted for small n . If n is large and p is small, then the Poisson approximation is appropriate.

REFERENCES

1. Clopper, C. J., and Pearson, E. S., "The Use of Confidence or Fiducial Limits Illustrated in the Case of the Binomial," *Biometrika*, 26(1934), 404-413.
2. Hoel, Paul G., *Introduction to Mathematical Statistics*, 3rd ed., John Wiley & Sons, Inc., 1962.
3. Larson, Harry R., "Nomograph of the Cumulative Binomial Distribution," *Industrial Quality Control*, 23(1966), 270-278.
4. National Bureau of Standards, *Tables of the Binomial Probability of Distribution*, Applied Mathematics Series, Vol. 6, 1950.

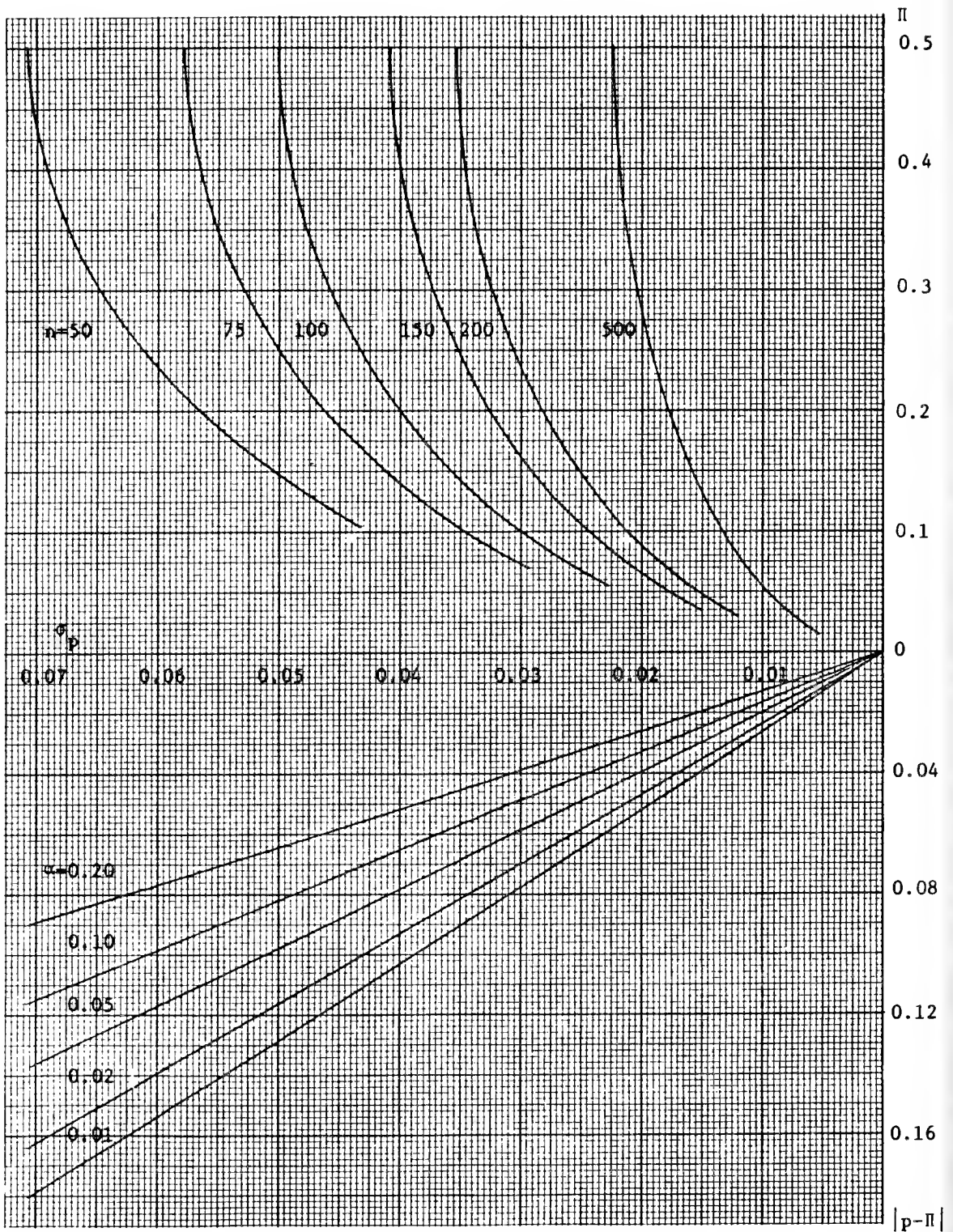


FIGURE 1. A nomograph for testing proportions.

Confederation Land Policy

FRAMING CONFEDERATION LAND POLICY: THE ROLE OF THE MASSACHUSETTS DELEGATION

John R. McCreary
Department of History
Columbus College
Columbus, Georgia

Throughout the various deliberations of the Continental Congress during the 1780's, one of the most persistent issues was that of the western lands. Few questions elicited more fratricidal tendencies in, or more parochial responses from, the various state delegations assembled in that impotent body. The land question was related to sectional voting alignments, to taxation at the federal level, to the regulation of commerce, and even to foreign affairs. Indeed, the issue played an important role in the delay by some states in the ratification of the Articles of Confederation.¹

Within this context, the Massachusetts Congressional delegation played a decisive role, both as the formulator of policy and the initiator of action. Representing one of the most influential of the new states, the Bay State's delegates enjoyed considerable influence in Congressional politics. Not always free from the myopia of parochialism and provincialism, they naturally sought first to protect the interests of their state, and frequently of members therein. In the process the delegation, variously and most prominently composed of Elbridge Gerry, Nathan Dane, Rufus King, Nathaniel Gorham and Samuel Osgood,² would play a decisive role in structuring the first American land system.

The Bay State had certain vested interests surrounding the question of the western lands. Specifically, it had the land claims in the territory known as Vermont, which was also claimed by New York, and it also held dormant claims to lands in western New York. Beyond this, however, Massachusetts political leaders came to feel a compelling need to establish the territory west of the mountains as a fund for sinking the national debt, a preponderant portion of which was in the hands of New England merchants and investors. The inability of Congress to

¹H.B. Adams, "Maryland's Influence upon Land Cessions," *Johns Hopkins University Studies in Historical and Political Sciences*, III (1885), 1-102.

²For biographical sketches of these individuals, see James L. Harrison, compl., *Biographical Directory of the American Congress, 1774-1949*, Seventh Edition (Washington, 1950).

establish a permanent revenue made imperative the effective utilization of the west.³

In September of 1780 Congress took a position favoring liberal cessions of territory to the national government in order to "establish the federal union on a fixed and permanent basis and on the principles acceptable to all its respective members...."⁴ Thus a public domain was established for the nation. Yet at the time this was hypothetical rather than tangible, for no states had as yet conveyed territory to the Congressional government *via* land cessions. Seven states claimed portions of the western lands, and all of them procrastinated in the actual ceding to the federal government. Conflicting state interests and competing land speculators clouded the issue. New York, Connecticut and Massachusetts could all assert a title to some of the land northwest of the Ohio River, and Virginia believed that the entire region was hers. The issue hinged less on whether the various states would or would not cede their lands to the Continental Congress than on Congressional acceptance of conditional cessions incorporating the particular state's interests. On this point the Massachusetts delegation adopted a nationalist position. Led by Samuel Osgood and Richard Jackson in 1782-83,⁵ they solidly held for unqualified cessions to the federal domain. Indeed, with only one exception the Massachusetts policy

³So great was the Massachusetts concern on this point that by 1782 the Massachusetts General Court addressed Congress on the subject, urging that all of the old Continental Currency be redeemed by 1783, and that the state governments be permitted to redeem all of the old paper held by their citizens if Congress could not act. Massachusetts State Papers, Vol. II, Address, Massachusetts General Court to John Hanson, President of Congress, October 21, 1782, Papers of the Continental Congress, 1774-1789, item 65, 201-02. (Hereafter referred to as Cont. Cong. Papers). By the early months of 1783, although Massachusetts had redeemed her own paper emissions of the war years, residents of the state held approximately forty-seven million dollars worth of the old continental paper, and her quota had already been paid. David Howell to the Governor of Rhode Island, September 9, 1783, Edmund C. Burnett, ed., *Letters of Members of the Continental Congress* (8 vols., Washington, 1921-36), VII, 291-93. (Hereafter referred to as *Letters of Members*). Robert Morris to Elbridge Gerry, August 26, 1783, Papers of Robert Morris, 1734-1806, Library of Congress, Morris Letterbook, Vol. F, 67-74, (Hereafter referred to as Morris Papers). Clearly, Massachusetts residents stood to absorb a considerable loss if a means to redeem or fund the outstanding continentals were not found.

⁴Roscoe R. Hill, *et al.*, eds., *Journals of the Continental Congress* (34 vols., Washington, 1904-1937), XVII, 806. (Hereafter referred to as JCC).

⁵JCC, XXIII, 551-53; XXIV, 256-57; XXVIII, 381-86.

in Congress favored unattached cessions: the exception being Connecticut's attempt to reserve a portion of the northwest for its own use.⁶

It was ironic that Massachusetts, although firmly committed to a nationalist land policy in Congress, was among the last of the states to extinguish her own western claims. This was less representative of provincialism than many have believed, however, and was in actuality explicable in terms of the state's desire to retrieve maximum advantage from an outstanding conflict with the state of New York. The two states were particularly in contention over the question of whether to admit to statehood the territory of Vermont, in which Massachusetts citizens had heavy investments. This was strongly opposed by New Yorkers, who hoped to maintain their tenuous claims that large portions of western Vermont were territories of New York.⁷ The result was to postpone the Vermont question until 1784, when it was once again referred to Congress. At that time the Massachusetts delegation, retaining the state's claims in Vermont, let it be known that if the question were decided in her favor, (meaning statehood for Vermont), she would cede the remainder of her claims to land west of the mountains to the Continental Congress.⁸ Once settlement of the Vermont question had been achieved, the Massachusetts delegates recommended to the state's General Court that all western claims be extinguished in favor of the central government, and in April of 1785 Rufus King and Samuel Holten placed before Congress an act ceding to the union all right and title to the soil and civil jurisdiction

⁶For a detailed analysis of the Connecticut question, see Larry R. Gerlach, "Firmness and Prudence: Connecticut, the Continental Congress, and the National Domain, 1776-1786," *Connecticut Historical Society Bulletin* (1966), 65-75. *JCC*, XXX, 229-34; 307-08; XXXI, 655. Further procrastination in the establishment of a clear national title to the western lands, at a time when a land ordinance was being frustrated by outstanding state claims, jeopardized the potential usefulness of the west as a sinking fund for the public debt, and thus the Massachusetts delegation was persuaded to accommodate Connecticut, hoping in the process to speed the effective utilization of those western lands.

⁷James Madison, Observations on Vermont and Territorial Claims, May 1, 1782, *Letters of Members*, VI, 340-41; Madison's Notes of Debates, November 14, 1782, *JCC*, XXIII, 849.

⁸James Monroe to Benjamin Harrison, Governor of Virginia, June 11, 1784, *Letters of Members*, VII, 551-52. Some have charged that Massachusetts' intention was to dominate the Union by admitting to it small states which could be controlled by the Bay State, (see Merrill Jensen, "The Creation of a National Domain," *Mississippi Valley Historical Review*, XXVI(1939), 323-42) protecting her land claims in the Vermont region, the Commonwealth sought to protect them in the only manner feasible; through the admission of Vermont to statehood.

over the state's western claims.⁹ The Bay state had not emphasized these claims, nor had she attempted, as had Connecticut, to take positive steps toward reserving western lands for a state domain. She had, nevertheless, made effective use of her tenuous claims, for in ceding them to the national government the state obtained a favorable response from a Congressional Committee which forced New York to compromise. In addition to settlement of the Vermont question, an agreement was obtained giving Massachusetts speculators the right to sell a considerable amount of land in the western sections of New York itself.¹⁰

The Massachusetts delegates had retained sight of their goal regarding the western lands. Early in 1782 they had gone on record in favor of a national domain, and had repeatedly urged other states to make unrestricted cessions. The Commonwealth's own position on land cessions became the lever to exact certain land titles from the state of New York, and to guarantee Vermont statehood, which prevented New York speculators from dominating the area and opened parts of the new state to Massachusetts investors instead.

With the successful establishment in 1785 of a national domain Congress, frequently pressed by men from the Commonwealth, turned to related questions: disposal of the new national resource and the accompanying problem of Indian policy. It was patently evident that the hopes of reviving the Confederation government rested almost exclusively with Congress's ability to exploit the new national domain. The Confederation stood literally at Armageddon; its finances in shambles and the impost defeated. Yet the western lands could successfully be tapped for revenue only if the Indian residents of the Ohio country could be placated. On this point the Massachusetts delegates, increasingly convinced of the efficacy of a national government while concomitantly discouraged with the prospects for the Continental Congress, staunchly clung to a nationalist point of view. Throughout 1783 and 1784 they pressed for a national Indian treaty, and attempted to resurrect British colonial policy under the Proclamation Line of 1763 by introducing a resolution prohibiting individuals from settling on Indian lands or purchasing such lands "without the express authority...of the United States in Congress assembled."¹¹ The threat of unrestricted immigration into Indian lands was of particular concern to the Massachusetts men,

⁹Elbridge Gerry to the Massachusetts Assembly, October 25, 1785; Massachusetts delegates to the Massachusetts Assembly, February 12, 1785, *Letters of Members*, VII, 604-05; VIII, 30-33; Reports of Committees on Indian Affairs and Lands in the Western Territory, April 4, 1784, Cont. Cong. Papers.

¹⁰*JCC*, XXVIII, 262; 271-73. See also Van Beck Hall, "The Commonwealth in the New Nation; 1780-1790" (unpublished doctoral dissertation, University of Wisconsin, 1965).

¹¹Massachusetts delegates to the Massachusetts General Court, October 16, 1783; delegates to the Court, October 23, 1783, *Letters of Members*, VII, 337-38; 349-50; *JCC*, XXV, 591-96, 602, 717-19. Signed by Elbridge Gerry, Samuel Holten, and Samuel Osgood.

Confederation Land Policy

for as Timothy Pickering noted "the Squatters are the least worthy subjects in the United States...little less savage than the Indians." Indeed, had the view of the Massachusetts delegation prevailed, the Confederation would likely have maintained a permanent military force on the frontier to prevent incursions and to maintain peace with the western tribes.¹²

Successful exploitation of the national domain depended to a great extent on the regularization of relations with the Indian, and the entirety of the Massachusetts Congressional delegation demonstrated that they were prepared to use the coercive power of the national government, such as it was, to restrict settlement impinging on Indian lands and thus to forestall a general Indian war. They actively supported Congressional pursuit of a policy which would peacefully extinguish Indian claims prior to settlement, so that amicable relations might be preserved and survey of the northwest might begin-- a survey which could proceed only if the western tribes chose to permit it.¹³

The acquisition of a public domain, and the erection of a framework for coherent Indian policy led to the most significant aspect of the land question during the Confederation; the formulation of a national policy for alienating and governing the western lands. In this endeavor the men from Massachusetts, intent as they were on exploiting this untapped

¹² Timothy Pickering to Rufus King, June 1 and June 4, 1785, Charles R. King, ed., *Life and Correspondence of Rufus King* (6 vols., New York, 1894-1900), I, 104-05, 106-07. (Hereafter referred to as *King Correspondence*). Rufus King to Elbridge Gerry, June 8, 1786 *Letters of Members*, VII, 384; Motion by King, June 16, 1786, Cont. Cong. Papers, item 58. In 1787 a Congressional committee headed by Nathan Dane of Massachusetts advocated the closing of the territory north and west of the Ohio to all travelers and traders except those licensed by the government, with violators to be severely punished by the military forces in the region. Reports of Committees on Indian Affairs and Lands in the Western Territory, July 26, 1787, Cont. Cong. Papers, item 30, 318-19. *JCC*, XXXIII, 596-97. The lack of any regular government in the west made Indian relations increasingly hazardous, and Kentuckians were restrained with great difficulty from killing Indians. See James Alton James, "Phases of the History of the Northwest," Mississippi Valley Historical Association, *Proceedings*, VII (1913-14), 168-95.

¹³ Reports of Committees on Indian Affairs and Lands in the Western Territory, October 15, 1783; Reports of Committees on Indian Affairs and Lands in the Western Territory, Reports to the president of Congress, January 28, 1785; Report of a Committee on King's Motion respecting holding a treaty with the Indians northwest of the Ohio River, June 29, 1785, Cont. Cong. Papers, item 30, 231; 271-73; 283-84; Elbridge Gerry to Stephen Higginson, March 4, 1784; Rufus King to Timothy Pickering, May 30, 1785; King to Gerry, October 19, 1786, *Letters of Members*, VII, 461; VIII, 132-33, 488.

reservoir to retire a public debt weighing heavily on Bay State citizenry,¹⁴ were to play a dominant role.

Several plans were offered for the disposal and sale of the western lands, one as early as 1783. Drawn up by Massachusetts General Timothy Pickering and other Continental Army officers at Newburg, it called for a frontier community composed of retired officers.¹⁵ A second proposal was brought before Congress in 1784. This was the product of a Congressional committee headed by Jefferson, which had been appointed to prepare a plan for the temporary government of the western territory.¹⁶ The plan completely ignored the problems of land division and sale, in which the Massachusetts delegation was vitally interested, and instead dwelled on the vagaries which typified much of Jefferson's thought. Neither of these ordinances was ever enacted, although the latter contained the seeds of sectional antagonism with its clause banning slavery from the northwest after 1800.

The slavery clause, together with other inadequacies, prevented passage of the so-called Ordinance of 1784, but the officers of the Continental Army continued to press for a land ordinance, hoping to redeem their back pay in land. Once again, the influence of Pickering was manifest. He contacted the entire Massachusetts state delegation, urging the establishment of a stable system for land disposal which would guarantee an orderly settlement of the western territory along lines tradition had created in New England. Whether out of race prejudice or moral objections, he also advocated the exclusion of slavery from the public domain, thereby rendering settlement more attractive to New Englanders.¹⁷ Acting on Pickering's suggestions, Rufus King on March 16 introduced a motion designed to revive the defeated proposition in the Ordinance of 1784 by moving that neither slavery nor involuntary servitude should exist in the new territories except as punishment for crimes, making the exclusion of slavery immediate rather than allowing it until 1800. The maneuver failed, and the Massachusetts delegation was forced to settle for a prohibition only after 1800,¹⁸ which was eventually incorporated in the Northwest

¹⁴Elbridge Gerry to Joseph Reed, May 5, 1784; See also Samuel Holten to Samuel Adams, April 11, 1784, *Letters of Members*, VII, 515; VIII, 86-7.

¹⁵JCC, XXVI, 89-90; 116-17.

¹⁶*Ibid.*, 118-19.

¹⁷Timothy Pickering to Elbridge Gerry, March 1, 1785; Pickering to Rufus King, March 8, 1785, *King Correspondence*, I, 72-73; Elbridge Gerry to Timothy Pickering, March 4, 1785, *Letters of Members*, VIII, 55. For a more extensive treatment of the Army and western lands, see Jean H. Vivian, "Military Land Bounties During the Revolutionary and Confederation Periods," *Maryland Historical Magazine*, LXI (1966), 321-56.

¹⁸JCC, XXVIII, 164-65, 239; Rufus King to Timothy Pickering, April 15, 1785, *Letters of Members*, VII, 94.

Confederation Land Policy

Ordinance of 1787. The persistence of the delegation on the point, however, indicates the degree of anti-Black sentiment in the Bay State's leadership.

The commonwealth's delegate interest in the formulation of land policy extended beyond the slavery question, however; indeed, it was ancillary to it. They brought to the land debates the determination that Congressional policy should reflect two goals of the New England mind: first, that the New England township system of survey and sale should be adhered to in all federal transactions, insisting that familial and religious ties which a township system encouraged would attract a more stable and thus more desirable type of settler to the frontier. Secondly, they adamantly opposed attempts to lower the minimum price *per* acre from one dollar to one-half dollar, fearing that if prices were set too low speculation would become a chronic problem.¹⁹ Thus the Massachusetts delegation would, in pursuing these demands, become directly responsible for the inclusion of two of the most debilitating aspects of Confederation land policy.

The question of land alienation exposed the open disagreement over the most desirable type of settlement: the corporate settlement of New England or the indiscriminate sale and settlement which typified the Virginia or southern approach to land disposal.²⁰ Failing to obtain total acceptance of their principles, King and Holten ultimately accepted a compromise in the Ordinance of 1785; one-half of the townships subdivided were to be sold in section, lots one mile square; the others were to be sold as units. The latter would presumably appeal to bodies of New England settlers. In the other half of the townships, a purchaser could select his 640 acres without waiting for the surrounding land to be sold. The only stipulation was that in the latter instance the tract selected must be bounded by sectional lines to reduce confusion.²¹

Among the New England states, Massachusetts had taken the lead in attempting to effect a Congressional land policy conformable to the system existing in their section, and the Land Ordinance of 1785 clearly bears their mark. Unfortunately, the Ordinance to which the Commonwealth's delegates had contributed so much sacrificed the immediate benefits of land sales for a well-ordered future. For

¹⁹William Grayson to George Washington, *Ibid.*, 95; Timothy Pickering to Rufus King, March 8, 1785, *King Correspondence*, I, 43-46; *JCC*, XXVIII, 292-93. Both Rufus King and Samuel Holten solidly supported a proposition to grant one section in each township to the support of religion, and another for the support of schools. *JCC*, XXVIII, 292-96.

²⁰Rufus King to Elbridge Gerry, April 26, 1785, *Letters of Members*, VIII, 104; *JCC*, XXVIII, 328-29, 336-38.

²¹*JCC*, XXVIII, 335-39. Rufus King to Timothy Pickering, May 8, 1785; King to Elbridge Gerry, May 8 and May 27, 1785; King to Pickering, May 30, 1785, *Letters of Members*, VIII, 113; 114-15; 123-24; 132-33.

while it did end the confusion of land claims and titles, the measure proved to be an ineffective vehicle for disposing of the western lands. The surveys were difficult to execute, and the entire process took entirely too much time.²² The Massachusetts delegation worked its way with the Confederation government, but the product of its labor was a land ordinance which would ultimately fail to achieve the goals of the Massachusetts citizenry with regard to the reduction of the national debt. The unrealistic price of one dollar *per* acre, coupled with a cumbersome need for survey first, saw only approximately 92,000 acres sold under the Ordinance of 1785--an amount hardly sufficient to enable Congress to meet its obligations.

The mere formulation of a method for disposing of the western lands might have proved adequate for many of the Congressional delegates, but for the Commonwealthmen Confederation efforts would remain incomplete until such time as the northwest territories came under a governmental structure which would assure New Englanders of a western society conformable to their own. Shortly after completion of the Land Ordinance of 1785, Nathan Dane and Rufus King, operating through committee pressed for adoption of a plan for territorial government. Following Dane's proposal the committee recommended that Congress establish governmental machinery prior to the sale of any territory. This machinery should, Dane argued, include a governor and a council of five, (to be appointed by Congress itself), with final decision-making powers to reside with the governor. While local residents would be allowed the suffrage franchise in selecting assemblymen, the powers of the territorial assembly were to be circumscribed by those of the governor.²³ Finally, in July Nathaniel Gorham, King, Theodore Sedgwick and Dane led the Congressional demand that Virginia alter its cession, making it possible to divide the territory north of the Ohio River into between three and five states, to be eventually admissible into the Federal union.²⁴

Congress passed the recommendation, but no action was taken by the Virginia Assembly. During the summer months of 1786, however, pressures built for the enactment of a permanent governmental form for the western lands. Led by King, the Bay State delegates opined that squatters and unlawful emigrants who were inundating the west would destroy the value of the western lands as a sinking fund, and that settlers to the western territories from the Atlantic states would be "forever lost to the Confederacy."²⁵ They were supported

²²For a discussion in more detail on the problems encountered, see Payson J. Treat, "Origin of the National Land System under the Confederation," *Annual Report of the American Historical Association for the Year 1905*, I, 232-39.

²³JCC, XX, 251-55.

²⁴*Ibid.*, 390-93.

²⁵Rufus King to Elbridge Gerry, June 4, 1786; King to Jonathan Jackson, September 3, 1786, *Letters of Members*, VIII, 380-82; 458-60.

in this contention by the Secretary at War Henry Knox. Also from Massachusetts, Knox would suggest, in the spring of 1787, that Congress use federal troops on the Ohio to regulate settlement and the taking-up of land.²⁶ In the autumn months of 1786 Congress considered Dane's original proposal, and adopted it a second time, but no further action could be taken. The Virginia legislature had not yet revised its cession to allow the establishment of territorial governments over its former holdings in the northwest.²⁷ Thus implementation of the 1785 Ordinance was stymied over the winter months of 1786-87. In the spring of that year, however, a new factor was introduced into Congressional politics: an offer was tendered Congress by the Ohio Company of Associates for the purchase of the northwest territory.

Citizens from Massachusetts had long played a leading role in the drive for an organized settlement west of the mountains. As early as May of 1783 General Timothy Pickering had proposed that Congress establish an army state in the Ohio country, a plan transmitted to Congress by another Bay State resident, General Rufus Putnam.²⁸ The plan bore no fruit, but the vision of a western colony of New Englanders was kept alive by Putnam and by yet another Revolutionary general from Massachusetts, Benjamin Tupper. The two men, determined to launch a land company, examined territory both in Maine and in the Ohio country, and having determined that the latter region offered the greater promise, formed a land company in 1786.²⁹ In the name of the Massachusetts-oriented Ohio Company of Associates, Putnam in 1787 proposed to pay one-half dollar *per* acre for lands north of the Ohio River, a sizeable portion of the sum to consist of public securities. Congress rejected the offer.³⁰

Having thus failed in his mission, Putnam turned the negotiations over to General Samuel Holden Parsons, a Continental Army veteran from

²⁶ Report of Henry Knox, April 19, 1787, *JCC*, XXXII, 222.

²⁷ *Ibid.*, XXI, 669-73.

²⁸ See Vivian, "Military Land Bounties," 243-56.

²⁹ See Shaw Livermore, *Early American Land Companies, Their Influence on Corporate Development* (New York, 1939), 133-36; Sidney Kaplan, "Veteran Officers and Politics in Massachusetts," *William and Mary Quarterly*, Third Series, IX (1952), 29-57. It was due to efforts of the Massachusetts delegation that Tupper was named to survey lands in the Ohio country when Putnam declined the post. *JCC*, XXIX, 542.

³⁰ William P. Cutler and Julia P. Cutler, eds., *Life, Journals, and Correspondence of Reverend Manasseh Cutler, LL.D.* (2 vols., Cincinnati, 1888), II, 192-93. (Hereafter referred to as *Cutler Journals*).

Connecticut and a charter member of the Ohio Associates. Parsons arrived in New York, where Congress was in session, late in March of 1787 and proposed a second purchase scheme. He offered one-half dollar per acre to be paid in Continental securities and in specie. As compensation for the price tendered, which was half that provided for in the Ordinance of 1785, Parsons offered to survey the land at the expense of the Ohio Company.³¹

This second assault by the Massachusetts speculators coincided with increased Congressional dissatisfaction over the provisions of the Ordinance of 1785. Early in April the Board of Treasury reported to Congress a plan for selling land. Noting that under the Ordinance of 1785 no lands could be alienated until seven ranges were surveyed, the Board pointed out that to date only 675,000 acres in twenty-six townships had been surveyed, and predicted that the survey of the requisite seven ranges would be incomplete in even another year. The Board therefore recommended that Congress alter the policy for land disposal by ignoring the provisions for completion of the survey. They continued to insist on a minimum purchase price of one dollar *per* acre, but consented to payment in public securities.³² Late in April Rufus King chaired a Congressional committee assigned the task of altering the process of land alienation. The committee advised a repeal of the Ordinance of 1785, substituting for the clause on surveys a provision whereby the purchaser would bear the expenses of the survey.³³

The way was now apparently cleared for Parsons, who again met with Congress in early May, proposing that a tract of land within the western territory be purchased by the Ohio Company of Associates for a sum "not exceeding \$1,000,000." Any of the associates entitled to military bounties were to have their lands assigned to them within the confines of the grant.³⁴ Somewhat to Parsons' surprise, however, the proposal was rejected by Congress, members of which were still determined to adhere to the original specie provisions of the Land Ordinance, and Parsons returned to Boston to lay further plans.

It was at this juncture, in the spring and summer of 1787, that the activities of Congress and the interests of the Ohio Associates meshed,

³¹The Reverend Manasseh Cutler to Nathan Dane, March 16, 1787, *Ibid.*, 194-95.

³²Reports of the Board of Treasury, April 4, 1787, Cont. Cong. Papers, item 139, 464-67; *JCC*, XXXII, 155-57.

³³Report of a committee on an ordinance for disposing of western territory, April 25, 1787, Cont. Cong. Papers, item 30, 129; April 26, 1787, *JCC*, XXXII, 239-41. Lands under this proposal might be chosen by districts, bounded by the Ohio River, with a surveyor to be appointed for each district. Locations were to be made wherever the locator might direct, provided that the district chosen joined some former entry on one side, and that no interstice more than half a mile wide separated any districts.

³⁴*JCC*, XXXII, 276.

resulting in the Northwest Ordinance. Congress continued its efforts toward the framing of a territorial government, and on May 10 an ordinance drafted by Nathan Dane and containing provisions similar to the now-defunct Ordinance of 1784 was reported and read.³⁵ No action was taken in Congress, however, due perhaps to the fact that the negotiations for sale had apparently collapsed. The Ohio Associates, however, had not lost sight of their goal, and commissioned another of their number, the Reverend Manasseh Cutler, as their new spokesman. Cutler, a Boston resident and a former Continental Army chaplain, arrived in New York early in July and spent the ensuing four days lobbying with Congress. He relied heavily on the Massachusetts delegates in the body, spending considerable time with King and Samuel Osgood in particular. Osgood was of inestimable value, since he had become a member of the Board of Treasury following his service as a Congressional delegate.³⁶

On July 10 the Massachusetts delegation presented Cutler with a copy of the May 10 draft, referring to territorial government. He suggested certain amendments to the document, including provisions for the support of religion and education, and the exclusion of slavery from the territory. Cutler made it plain that the Ohio Associates expected to have these matters settled prior to the consummation of any purchase.³⁷ The Massachusetts company was anxious to have the land, but only on their own terms; terms which would permit them to offer attractive inducements to prospective New England settlers. Cutler's pressure, executed to a great extent through the Bay State's Congressional delegates, re-opened action on Dane's May 10 ordinance. On July 13 the amended ordinance was read a third time, and passed. In its new form it included provisions for the protection of estates and inheritances, guarantees of civil and religious liberties commensurate with the original states, and most importantly, a prohibition of slavery and involuntary servitude,³⁸ this being perhaps the only means of assuring a free, white society in the northwest.

In these details, the Ordinance of 1787, otherwise known as the Northwest Ordinance, differed from the May 10 draft prepared by Nathan Dane. That draft had not included the controversial anti-slavery article, and for that reason Cutler distrusted Dane, whom he believed all too willing to compromise with the Southern delegates on this point.³⁹ Dane, however, worked doggedly for Congressional adoption of the Ohio Company's proposal, as did Samuel Holten. Valuable assistance had already been

³⁵*Ibid.*, 281-83.

³⁶*Cutler Journals*, I, 230-42.

³⁷*Ibid.*, 242-43.

³⁸*JCC*, XXXII, 334-43.

³⁹*Cutler Journals*, I, 293-94; Nathan Dane to Rufus King, July 16, 1787, *Letters of Members*, VIII, 621-22.

rendered by Samuel Osgood, whose position on the Treasury Board gave him considerable influence.⁴⁰ On July 27 the lobbying talents of Cutler and the political influence of the Massachusetts delegation were vindicated by Congressional acceptance of the contract.⁴¹

The final sale was somewhat different from that which was originally proposed. The Ohio Company of Associates, given the opportunity to purchase one and one-half million acres of western land from Congress, was forced to combine its offers with those of William Duer's New York-based Scioto Group of speculators in order to obtain the requisite financial backing and thus complete the transaction. Fronting for the Scioto Group, the Ohio Company obtained a grant of nearly 5,000,000 acres, at a price of roughly three and one-half million dollars. Once this was completed, a million and a half acres was to go to the Ohio Company, and the remainder to Scioto.⁴²

Thus the first comprehensive program for the west was completed, and in it and Massachusetts Congressional delegation had played a decisive role. The eventual outcome of the land question pleased Bay State delegates and speculators alike. They were convinced that Congress had "made a certain source for sinking a large part of the domestic debt of the Union," and at the same time had, through the Northwest Ordinance of 1787 rendered these new lands "inviting to settlers,"⁴³ and merchantable by the Massachusetts-based Ohio Company of Associates. A semblance of the New England township system had been retained, whereby the Ohio Company could appeal to New Englanders in their sales propaganda, and of equal importance was the exclusion of slavery from the territories. The Negro's presence in the northwest would not be permitted, thus eliminating a potential deterrent to New England settlement.

Desiring two things from the western lands--reduction of the national debt and stability in the territories--Massachusetts spokesmen pressed for incorporation of these two points in any land policy adopted by the

⁴⁰JCC, XXXII, 376-77; *Cutler Journals*, I, 299-300; 302.

⁴¹JCC, XXXIII, 427-30.

⁴²*Cutler Journals*, I, 303-05. Apparently the New York-based Scioto Group was able to obtain the necessary amount of Continental currency with which the Ohio Associates were to complete their purchase. See A.B. Hulbert, "Methods of Operations of the Scioto Group," *Mississippi Valley Historical Review*, I (1915), 502-15; Robert A. East, *Business Enterprise in the American Revolutionary Era* (New York, 1938), 318-19; Livermore, *Early American Land Companies*, 138-39; and Theodore C. Pease, "The Ordinance of 1787," *Mississippi Valley Historical Review*, XXV (1938), 167-80.

⁴³Massachusetts delegates to Governor Hancock, May 27, 1788, *Letters of Members*, VIII, 739-41.

Confederation Land Policy

Confederation government. They consistently urged the creation of a national domain and had, although territorial disputes with New York retarded their own cession, pressed for unrestricted cessions, so that the national domain would be both governable and merchantable. The Commonwealth's representatives acted out of guarded self-interest in emphasizing the establishment of a federal domain; hoping to reduce the national debt by these means, while concurrently insuring a reserve to sink part of her own state debts.

The western territory, however, could not be tapped as a means of revenue until stable Indian relations were achieved. On this point also, the Bay State's delegates stood solidly for effective federal authority. They uniformly opposed attempts by various states to formulate or execute Indian policy. Taking a negative view toward unrestricted frontier settlement, lest the Indians be aroused, they attempted to ameliorate clashes between Redman and settler by using the federal power to police frontier areas against incursions onto Indian lands. They also supported a federal treaty which would hopefully extinguish claims held by the Indians to the northwest. Until the Indian question were settled, the west would produce neither income nor stability.

Coincident with their aspirations for the west, the Massachusetts men resolutely supported the anti-slavery clause on the theory that it would make the west more attractive to the New England settler. They pressed for educational and religious reservations to encourage purchase and settlement along the lines of the New England township, and blocked most attempts by Southern delegations to institute a policy of random, indiscriminate purchase. In fact, they led the Congressional fight to enforce regularized surveys which finally resulted in the compromise Ordinance of 1785, and the preservation, in part, of the New England township system in federal land policy.

The Massachusetts delegation was in contact with the Reverend Manasseh Cutler, and warmly supported his case in Congress. Aware that to adhere to the strict provisions of the Ordinance of 1785 would prejudice any land sale for at least another year, they successfully pressed for a revision of that Ordinance, and for the enactment of a territorial formula capable of ensuring constructive settlement. Culminating Confederation land policy, the Northwest Ordinance of 1787 represented at least a sizeable victory for the Massachusetts Congressional delegation. Assuring the first sizeable purchase, it accomplished the two objectives of the delegates; it made the western lands a sinking fund for the public debt, and it provided a plan of territorial government conducive to orderly and stable settlement. It incorporated the best features of the New England township system with the potential to sell in volume sufficient to assist in liquidating the public debt.

COMPOST--THE UNORTHODOX WAY FOR ORGANIC GARDENERS

Emmett B. Carmichael¹

University of Alabama, Birmingham

For every true gardener who expects success from his efforts, nothing is more rewarding than a compost pit. A compost pit can be made by one of the following three methods:

1. Simple stacks or ricks of organic material on the ground.
2. A series of boxes such as the New Zealand Box Method.
3. Permanent enclosure of concrete and brick that prevents contact of the compost materials with the earth.

No pit could be more effective and permanent than the simple "Unorthodox Compost Pit" described in this paper. Organic compost for the pit is prepared by mixing leaves, vegetables, fruits, minerals, earthworms, and water in proper proportions and under ideal conditions. A preliminary report on the method was presented previously.²

After trying the open pit method of composting for several years at Tuscaloosa, Alabama, I decided to abandon it because roots from the trees and privet hedge found their way into the open pit and absorbed the nutrient materials. After a year, the decomposed materials in the pit had been thoroughly penetrated by countless numbers of fine roots, which were the culprits.

Some twelve years ago I decided to build an enclosed compost pit that would keep out tree roots. Since my lot extended about four feet beyond my garage, and since a privet hedge was growing just south of the lot, I decided to make use of the south wall of the garage as the north wall of the pit. The hedge would hide the pit from ordinary view.

A concrete floor about 4 inches thick was poured next to the south wall of the garage, which is 18 feet and 4 inches long. The floor was 4 feet wide. After the concrete had hardened for a few days, a wall 5 feet high was laid using concrete and old bricks placed end to end. The new wall extended across the back end of the pit and along the south edge of the concrete floor. The south wall of the garage became the north wall of the pit. This resulted in a closed pit (Figure 1) so that none of the "compost water" could drain off or be absorbed by the earth.

To reinforce the walls and to avoid damage from pressure in case the wet compost should freeze, the back wall and the south wall were reinforced with a 3 inch lining of concrete to a height of 2 feet.

¹Professor of Biochemistry Emeritus, University of Alabama Medical Center.

²Carmichael, Emmett B., The Unorthodox Compost Method for Organic Gardeners. *Journal of the Alabama Academy of Science*, 38:318-319, October, 1967. (Abstr.)

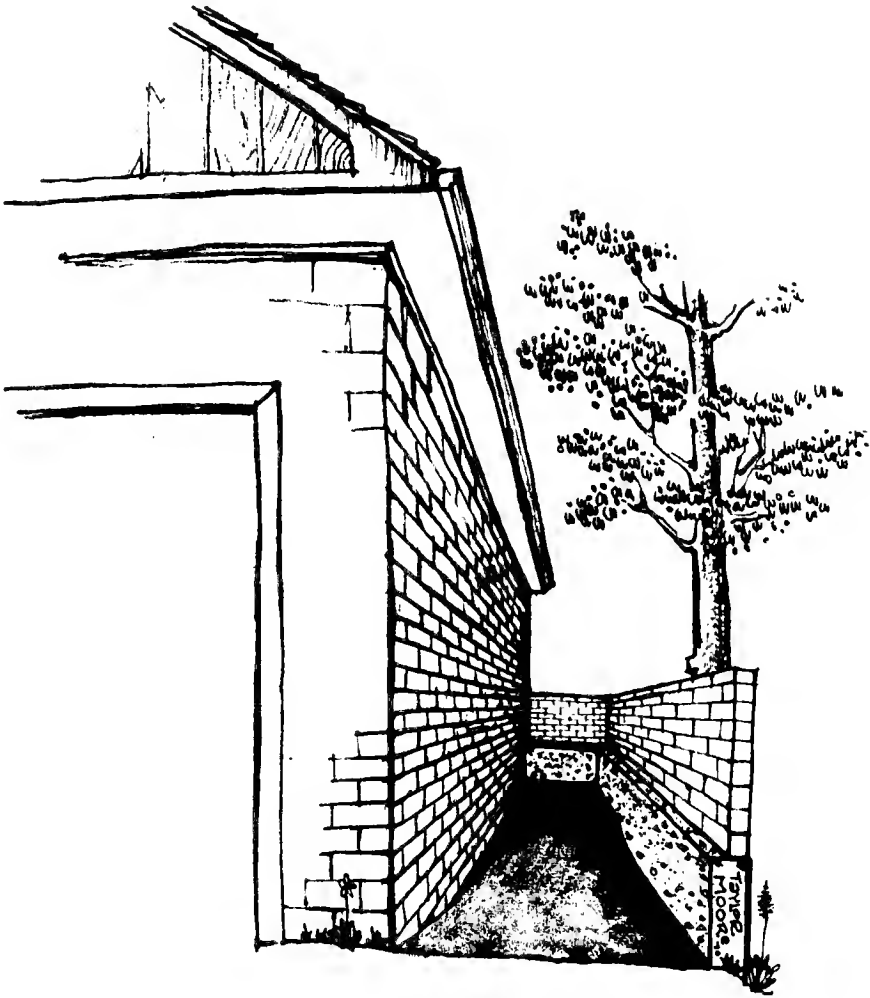


FIGURE 1. Completed compost pit

Concrete blocks were used as a temporary front wall; they were laid about 6 feet high. This allowed for stacking the compost materials as high as possible to compensate for shrinkage. The completed pit has a capacity of about three hundred bushels.

Materials used to make the compost filled the pit during the first fall and winter. Then, just before leaf-fall began the following autumn, all of the compost was moved to the front of the pit (Figure 2). This procedure made space for about two hundred bushels of new leaves. The plan was to keep the original materials in the pit for a second year, since a good percentage of the oak leaves were not completely decomposed. Also, the second year would help to destroy seeds of various weeds. During the second year, there seemed to be complete decomposition of the materials, resulting in a rich organic compost.

At the end of 2 years, the temporary front wall was removed and 2-year-old compost placed on a concrete apron by the garage where it was available for use. The front wall was then replaced, and the 1-year-old

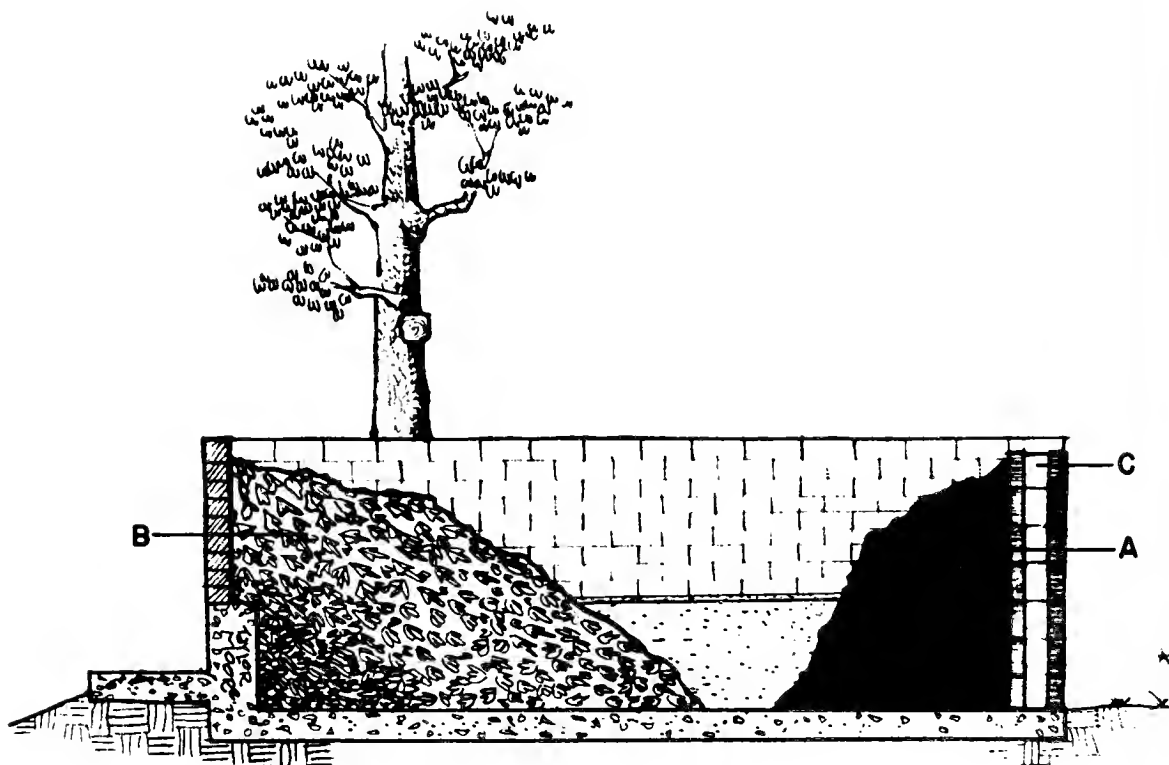


FIGURE 2. Longitudinal section view of compost pit. A) Year-old compost material moved to front of pit. B) New compost material (leaves, etc.) added. C) Temporary front wall of pit.

compost was moved to the front of the pit as before and allowed to decompose for a second year. This left about two-thirds of the capacity of the pit empty for the next crop of leaves and other materials. However, before the new crop of leaves was added, approximately 1 bushel of the 2-year-old compost was placed at the far end of the pit and stocked with a supply of earthworms. This insured that worms would be active throughout the pit. As the new leaves were added, they were well watered to insure survival of the earthworms and to aid in the decomposition of the materials.

A word of caution may be in order if the organic compost is added to hydrangea shrubs that produce blue flowers. When a large application of the compost was added in the fall, the plants produced dark purplish to red flowers the next year. With the addition of small amounts of the compost annually, the flowers have held the pinkish red shade for several years and have not reverted back to the blue color.

The above regime of filling the pit has been followed for 12 years and the annual yield varied from 25 to 50 bushels of the rich compost. The annual yield has depended almost entirely on how many leaves were harvested before the wind blew them off the yard.

In addition to oak leaves, the following materials were added to

insure a rich compost and one that would decompose rather quickly: trimming from all vegetables; peelings from fruits; shucks and cobs from corn; melon rinds; clippings from the lawn; old leaves and stems of flowers such as Iris, narcissus and lilies; egg shells; and used cat litter. Some commercial fertilizer (8-8-8) and lime were added to insure the growth of bacteria and fungi (molds) and to create suitable environment for enzyme activity. Fruits and vegetables such as rotted or molded tomatoes, apples, potatoes, and citrus fruits have been added to the pit to incorporate fresh sources of bacteria and fungi, which maintain active decomposition of the materials. In warm weather these materials were buried in the compost to avoid attracting flying insects.

Water was always added when fresh leaves were dumped into the pit, and water was added periodically to keep the contents of the pit moist at all times.

Earthworms were placed in the pit when the first leaves were added in the fall, and earthworms have been added periodically since that time; a supply of earthworms can be collected during routine cultivating or digging around shrubs and other plants. The worms not only digest some of the compost materials but help to aerate the materials and generally speed-up decomposition. When the 2-year-old compost was removed from the pit, many of the earthworms were caught and returned to the pit. This has been somewhat necessary to maintain the stock since some of our bird friends, particularly robins, made regular visits to the compost pit to feed on the worms as they came near the surface of the compost.

THE GERMAN WORKING CLASS MOVEMENT AND THE AUSTRO-PRUSSIAN
WAR OF 1866

William H. Maehl
Department of History
Auburn University, Auburn, Alabama

Neither 1875, the year of Gotha, nor 1869, that of Eisenach, but 1866, the year of the Austro-Prussian War, was the fork in the roads for the German working class movement. Its two wings pursued tactics during the war, that ever afterward made it impossible to adopt an insurrectionary posture. The one wing looked for support and realization of its goals to authoritarian Prussia, thought the inclusion of Austria-Hungary in a German federation would cripple it, and was content to operate within the framework of a Hohenzollern-dominated Reich. The other wing sought alliance with the democratically oriented petty bourgeoisie and the South German particularists, who thought of Bismarck as Lucifer and the Wilhelmstrasse as being in the latitude of hell. This wing believed, as did Franz Schnabel in our century, that it was a fundamental error to begin the unification of Germany by excluding Austria-Hungary from it. In later years neither wing was able to rid itself of the Shirt of Nessus it had donned in its adolescence: the one could not cut its Prussian, the other its middle class connections. As a result, the future German Socialist movement was never able in practice to repudiate reformism and focus its gaze upon the forcible overthrow of the existing political and economic establishment.

Bismarck, who not only wished to strengthen Prussia but serve the entire German nation,¹ knew that he must enlist the masses for the realization of his program. This he tried to do by promising the democratic franchise and by implying that more concessions would be made to a working class that identified itself with his grand political objectives. For their part, the bourgeois democrats tried to give to the many working class clubs they had organized a non-political, cultural slant to divert them from radical escapades such as had plagued the revolutions of 1848. Thus it was that the entire German working class was being subjected to efforts, whether from Bismarck or his foes, to domesticate it.

Both of the two main "workers'" organizations in 1866 were small and largely confined to the area North of the Main river. Neither was Marxist. The more politically minded of the two organizations had been founded by Ferdinand Lassalle on May 23, 1863 and was called the *Allgemeiner Deutsche Arbeiterverein* (ADAV) or General German Workers' Association. The other, an outgrowth of the amalgamation of scores of workers' cultural and educational associations (*Arbeiterbildungsvereine*), was labelled the *Verband Deutscher Arbeitervereine* (VDAV) or Federation of German Workers' Associations and had been founded in June 1863.

The Lassallean ADAV, whose membership was mainly Prussian,² was pro-Bismarckian and politically more conservative than its rival. The ADAV was still completely dominated by the spirit of Lassalle, who had never been a revolutionary,³ but, in the words of Marx, had only been "an enlightened Bonapartist,"⁴ which is to say, an imperialist.⁵ In spite of all disclaimer of sympathy with the *Kleindeutsch* solution of the German problem, Lassalle

had really been more pro-Prussian than the king of Prussia. The net effect of Lassalle's propaganda had been to win over a considerable part of the urban workers for the dismantling of the Austrian empire and the construction of a Germany dominated by Prussia. In striving for a *modus vivendi* with Bismarck, Lassalle adjourned the fight against the semi-feudal nobility and married the working class to the Hohenzollern dynasty.⁶ Yet it cannot seriously be denied that in fusing the workers with a movement that transcended class or borders, Lassalle had unquestionably served the best interests of all Germans and bequeathed a patriotic legacy to the future Social Democratic Party.

The VDAV was from the outset heavily influenced by two circumstances. First, its greatest strength lay in Saxony, a state that had been Prussia's migraine for more than a hundred and fifty years. Second, the VDAV was genetically a hybrid of petty bourgeois and working class strains. On the eve of war it was far less compact or ideologically unified than was the ADAV under Lassalle's successors, Johann P. Becker and Johann Baptist von Schweitzer.⁷ The Federation of German Workers' Associations, whose chairman was the bourgeois Leopold Sonnemann but whose most active leaders were the professional "Marxist" Wilhelm Liebknecht and the turner August Bebel of Leipzig, subscribed to the political aims of the petty bourgeoisie. The VDAV was, as respects its theses on government and army, the heir, in fact, of early nineteenth century Liberalism. The organization's ambivalence was aggravated by the circumstance that many of its members simultaneously belonged to the middle class German People's Party (*Deutsche Volkspartei*) and some one of its regional affiliates, such as the Saxon People's Party. The cardinal aim of these various populist parties was to prevent the ingestion of the secondary states by Prussia. This policy was reduced to positive terms by the VDAV when at its September, 1865 convention at Stuttgart Karl Meyer of Württemberg secured overwhelming approval of his proposal that Germany be unified on exclusively republican and democratic bases.⁸

The attitude of the ADAV towards Bismarck was, on the other hand, a reflex of its animus towards the bourgeoisie. The determination of Lassalle and Schweitzer to tear the masses away from their middle class guardians⁹ would have left the ADAV isolated and without influence had it not flirted with the socially minded wing of the Prussian Conservative Party. However, it is also true that the ADAV lent qualified support to Bismarck, the first European statesman to propose universal, equal manhood suffrage, in the conviction that his program would advance the interests of the working class. The perpetuation of the German small states system (*Kleinstaaterei*), it was believed, would only subvert them. The ADAV's enthusiasm for the chancellor's consolidationist program proceeded to the point where Schweitzer even called for the absorption of all Germans in Central Europe, including Bohemia, into an organic, unitary state rather than a mere *Bundesstaat*.¹⁰

Tactical considerations also governed the policy of the VDAV. Its attitudes were heavily influenced by its indebtedness to the bourgeoisie. Most of the more than one hundred, non-political workers' educational cells that comprised the VDAV had been founded by middle class progressives and were subsidized by them.¹¹ The latter were foes of

Bismarck's three year military service program and of his unconstitutional procedure of financing governmental operations without legislative assent. Since the VDAV was in 1866 wholly dependent upon Liberal deputies to represent its interests, the Federation of German Workers' Associations was for the time being inclined to accept the tutelage of bourgeois democrats.¹²

In Saxony, which was the most advanced industrial area in Germany outside the Ruhr, the VDAV possessed a strong base for its struggle against the feudal nobility and Prussian military autocracy. The Saxon campaign was launched from Leipzig and captained by Liebknecht and Bebel. They toiled to pry the workers loose from a developing connection with Prussian-nationalist forces.¹³ This involved a bitter fight with the Lassalleans, which, however, only began after Liebknecht had been expelled from the ADAV and he, Engels and Marx had deserted its central organ, Schweitzer's *Sozial-Demokrat*. This had happened in the spring of 1865, partly because of their resentment towards Schweitzer for having written and published a series of pro-Bismarckian articles.¹⁴ Very shortly afterwards the Lassalleans had split into a Hatzfeldt and a Schweitzer faction. It was then, with the foe in seeming decomposition, that the leaders of the VDAV--Sonnemann, Staudinger, König, Richter, Hirsch, Lange, Liebknecht and Bebel -- attacked the Lassalleans with a vengeance.¹⁵ They seized on Schweitzer's overtures to Bismarck to make it appear that the former had betrayed the workers.¹⁶

The VDAV's champion was the Hessian-born Liebknecht, whom Marx and Engels called "Library" or "Wilhelmchen". A fiery and effective orator for whom revolutionary policy was really subordinate to the fight against the Hohenzollerns and Bismarck, Liebknecht never forgave them for having expelled him from Prussia.¹⁷ For years after July, 1865 he was a man with a grudge, and hence for Marx and Engels something of a bore. Liebknecht was more concerned over the fight against the living Bismarck than the dead Lassalle and was therefore able to give only a distorted reflection of the revolutionary thinking of the London "general staff".¹⁸ Nevertheless, Liebknecht was unquestionably fortified in his Prussophobia by the fact that in the spring of 1866 Marx and Engels still grossly underestimated Bismarck's capabilities. They thought he would stumble diplomatically and be overthrown, as a result of which revolution might break out, and Germany would be united from below rather than from above.¹⁹

VDAV leaders naively believed that Bismarck was an unprincipled villain who would not hesitate, for the sake of Hohenzollern territorial ambitions, to involve Germany in civil war. This estimate was hardly to be distinguished from that of the South German governments and the People's parties.²⁰ The only difference was that the latter two thought Prussia could be thwarted by forming a federation of non-Prussian neutral states, whereas the VDAV knew that the princes could not be trusted to adhere to such policy and thought that the proper reply to Bismarck in case of war with Austria was the *levée en masse*, such as the French had thrown together against the Prussians and Austrians in 1793.²¹

The mass levy, which had not even been tried in 1813 but was confidently proposed by Bebel and Liebknecht, elicited a mirthless laugh from Engels.

Considering the complexities of modern technology and logistics, the "General" in London knew that the half-trained militia solution could not protect a "state of the middle," such as Prussia, against a Franco-Austrian or Franco-Russian combination. That could only be done on the basis of a mass conscript, highly trained and well-equipped army, such as Roon and Moltke were building.²² Moreover, social revolution could only come about, thought Marx and Engels, as a result of a war of annihilation in which the beaten power would be either broken or utterly exhausted. Only a barracks-trained, conscript army could wage such a war. Marx and Engels, who viewed all wars from the standpoint of whether they were likely to advance the cause of world revolution,²³ concluded that Bebel and Liebknecht were in grievous error to view the whole German military problem from the internal standpoint. For the workers, no less than for Bismarck, the primacy of foreign policy (*Primat der Aussenpolitik*) was a categorical imperative.

Disagreement between the London oracles and the VDAV leaders respecting tactics obscured their fundamental agreement as to the desirability of an Austrian victory. Marx and Engels backed the Habsburg empire, not out of jejune hatred of the Prussian "military monarchy" or because they truly believed in the military superiority of Benedek's army over Moltke's, but because an Austrian effort to impose a *grossdeutsch* solution upon Germany might well provoke the revolution. This wish inspired Engels to indulge in fantastic armchair exercises that led him to predict a speedy military victory for Austria.²⁵

Clearly, Engels, whom Marxists call "the first military expert of the revolutionary proletariat,"²⁶ brought strong reenforcement to the VDAV's offensive against Prussia.²⁷ Sonnemann, Liebknecht, Buchner, Staudinger, Bebel and most VDAV leaders believed that the regular armies of the secondary German states supplemented by a people's militia would defeat Prussia. But the beauty of this analysis was that Austria would achieve only a Cadmean victory which would end by destroying her and being the prelude to that bourgeois-democratic revolution which was the maximum goal of the VDAV. Naturally this unrealistic estimate ignored the possibility that an Austrian victory might fortify rather than erode the Habsburg monarchy and entail a more reactionary, anti-nationalist settlement than would a Prussian triumph.

In connection with their propaganda campaign of the spring of 1866 against Prussia, Liebknecht and Bebel staged a mass rally in Leipzig on May 8th. At it they secured unanimous adoption of a resolution which blamed the current crisis upon Prussia and its supporters in the *Nationalverein* and *Gothaverein*, rejected the idea of an hereditary national German monarchy and called for a people's militia (*Volksheer*) to lead the nation in defense of its territory and freedoms against the Hohenzollern monarchy.²⁸ Again, on May 20th at Frankfurt a/M Bebel addressed a national rally, which was attended by personages such as Bennigsen, Sonnemann, Welcker, and Struve. He traduced the notion of neutrality and finished on a strident, hortatory note:

As far as the present crisis is concerned, no one will deny that Prussia has provoked it. . . . If, notwithstanding, war were to break out, it is to be hoped that the entire nation will rise up and march against Prussia, the violator of the peace.²⁹

The assembly at Frankfurt then passed a resolution in the sense urged by Bebel.³⁰ Subsequently, similar resolutions were passed by VDAV organizations in Mannheim, Hanau, certain districts of Berlin, and by People's party cells in almost all of South Germany.³¹

Despite all loose talk about a democratic-republican federation, it was as a champion of old Germanic liberties and *Kleinstaaterei* that the VDAV entered the lists in 1866. It was from a practically reactionary standpoint that the central committee of the VDAV demanded the repulse of Moltke's armies.³² On June 24, nine days after commencement of the war, that committee, acting on the advice of Liebknecht and Bebel, adopted a program designed to promote an Austrian victory.³³

So busy was the VDAV with the preparation of poisons in its apothecary shop that the leaders failed to draw the lessons from the split in the Liberal Party and the concentration of almost all Lassalleans around Bismarck's standard. The VDAV should have been forewarned that Lassalle's ideas were determinative for most German workers, just as his economic concepts were, in Bebel's words, "for most the A,B,C of socialism."³⁴ Even after the Battle of Königgrätz (July 3rd), Liebknecht and Bebel do not appear to have reconciled themselves to the Prussian *fait accompli*. Liebknecht continued to insist that the "historical process must be accelerated and Prussia hindered from consolidating" the area North of the Main river. The overthrow of Prussia was for him still "tantamount to the victory of the German Revolution."³⁵ For him, it was either "with Prussia against Germany, or with Germany against Prussia."³⁶ He could not see that any good might accrue to the workers as a result of Bismarck's actions.³⁷

Engels and Marx, on the other hand, believed that as a result of the creation of the North German Confederation the cause of the proletarian revolution would be promoted.³⁸ Marx wrote in disgust: Liebknecht "hasn't the slightest conception of revolutionary policy."³⁹ Engels expressed alarm at the fantastic lengths to which "Wilhelmchen's" Austrophilism was leading him even after peace had been signed.⁴⁰

Very probably the position of the VDAV was balefully influenced by its sticky connection with a petty bourgeois secondary state movement which equated *Kleinstaaterei* with German liberty.⁴¹ By contrast, the Lassallean majority, under Schweitzer, never wavered in its condemnation of *Kleinstaaterei* as an incubus on the chest of the German working class and the principal impediment to Germany's rise to world power.⁴² After Königgrätz, Schweitzer took the practical view that it must now be the task of the workers to force the Hohenzollern monarchy and the Conservative Party to effect a genuine merger of Prussia with Germany because national unity was the precondition of democracy.⁴³ The Erfurt Convention of the ADAV of December 1866 approved his recommendations.⁴⁴

Meanwhile, in their first year as deputies to the North German Confederation's Reichstag Bebel and Liebknecht continued to denounce the Prussian achievement. Bebel accused Prussia of turning Germany into one vast barracks and destroying the last vestiges of freedom. On April 10, 1867 he declared that "in founding the Confederation Prussia was in no

way concerned with unifying Germany." Bismarck had only wanted "to advance a specifically Prussian aim -- the strengthening of Hohenzollern *Hausmacht*."45 Said he:

Gentlemen, if you will consider the Confederation closely, you will have to admit that the relationship of the small states to Prussia is utterly abnormal, that this Confederation is only a Greater Prussia surrounded by a shoal of vassal states whose governments are nothing more than governor generalships of the Prussian crown.46

Bebel amazed his audience by somewhat contradictorily indicting Prussia as much for her omissions as her commissions. He flayed the ministry for having neglected to bring the South German states into the North German Confederation and, to the disgust of Bismarck who was in the chamber, declared that "if the French had tried to interfere, all Germany would have risen as one man to repel intervention in its internal affairs."47 Bebel ventured to predict that "the Prussian government in the future, as today, will always oppose the entrance of South Germany into the Confederation," and he said that he "must decisively protest against a Confederation which proclaims not the unity but the division of Germany. . . ."48

Bebel pursued this line of attack further when on September 24, 1867 he delivered an irredentist speech before the Reichstag. He accused Prussia of having abandoned 18,000,000 Germans in Austria, Luxemburg, North Schleswig, Bohemia, and the Baltic lands.49 Liebknecht also spoke on behalf of a Greater Germany on October 17th.50 Thus these men, who had by then become the acknowledged spokesmen of the VDAV, ended by advocating, in effect, an impermissible extension of Prussian autocracy (which they execrated) to lands that had never before known it. With an imperialistic verve that would have shamed the Frankfurt Assembly of 1848, Bebel and Liebknecht urged a line of action that ran the risk of a continental war.

Such utterances in no way eliminated the blatant doctrinal inconsistencies in the position of the leaders of the VDAV. Thus on December 11, 1867 Liebknecht wrote Engels: "*Il faut corriger la fortune* Prussia must be hindered in consolidation."51 His incapability of leading the masses was garrishly highlighted by the incredible addendum: "Prussia is now relatively weak, weaker than before the war,"52 which led him to infer that her overthrow, which he equated with social revolution, was close at hand.53

Yet even as respects the gospel of revolution, Liebknecht, Bebel and the whole VDAV leadership were prisoners of their Liberal antecedents. At a time when Schweitzer was still a powerful force in the German workers' movement, the VDAV could not afford to alienate the lower middle class. If Liebknecht and Bebel had sincerely embraced the anti-capitalistic revolutionary formula, they would have had to break with the petty bourgeois democrats. As was demonstrated at the Nuremberg convention of the VDAV in September, 1868, this would have meant driving the delegates of at least twenty-six towns and cities out of the Federation of German Workers' Associations.54 But Bebel and Liebknecht had no intention, then or later, of crossing the Rubicon. They made much ado about founding

a Social Democratic Workers Party (The Eisenachers of 1869) but, Marxist historians notwithstanding, never cut the line to the bureaucracy and lower middle class, which accounts for the later chronic contradiction between theory and practice in German Socialist policy. As Liebknecht unconvincingly said to Engels when the latter chided him for the VDAV's continuing association with South German federalists and petty bourgeois elements, "Politics, like misery, gives you strange bedfellows. The lamentable weakness and helplessness of the workers. . . leaves no other choice."⁵⁵ To found a revolutionary socialist party was, as G. Mayer, G. Ebersold, Vera Vrona, Max Hochdorf and many others have averred, far from the minds of VDAV leaders.⁵⁶

It is plain that the fundamentally petty bourgeois aims and tactics in 1866 of the Federation of German Workers' Associations determined its eventual destiny. The VDAV's grand policy remained anti-Prussian and fundamentally sterile until at least 1871, whereas that of the Lassalleans, who had been proved right in 1866, continued to be pro-Prussian and positive. However, neither movement was revolutionary, and both could agree on the gradualist approach to power. It was that factor that made possible the merger of the two movements at Gotha in 1875. The post-Gotha Social Democratic Party, heavily freighted with reformist middle class concepts, directed its agitation almost wholly towards the democratization of the Prussian monarchy and the Bismarckian empire rather than their forcible overthrow. Lassalle could not have wished for a better ending.

FOOTNOTES

¹Ritter, Gerhard. 1958. Das politische Problem des Militarismus in Deutschland. In *Lebendige Vergangenheit*. Verlag R. Oldenbourg, Munich, p. 167.

²Mayer, Gustav. 1912. Die Trennung der proletarischen von der bürgerlichen Demokratie in Deutschland, 1863-70. *Archiv für die Geschichte des Sozialismus und der Arbeiterbewegung*, 2: 1.

³Bernstein, Eduard. 1919. Ferdinand Lassalle und seine Bedeutung für die Arbeiterklasse. *Buchhandlung Vorwärts*, Paul Singer, Berline, pp. 57-63; Mayer, Gustav. 1934. *Friedrich Engels: Eine Biographie*. Martinus Nijhoff, The Hague, II, 121; cf Lassalle, Ferdinand. 1919. *Gesammelte Reden und Schriften*, ed. by E. Bernstein. Berlin, III, 261-62; 275-77.

⁴Marx, Karl and Friedrich Engels. 1949. *Briefwechsel*. Dietz Verlag, Berlin, III, 101.

⁵For corroboration see Lassalle, *Gesammelte Reden und Schriften*, IV, 306.

⁶Cf Benser, Günter. 1956. *Zur Herausbildung der Eisenacher Partei*. Dietz Verlag, Berlin, p. 35.

⁷Mayer, Gustav. 1907. *Die Lösung der deutschen Frage im Jahre 1866 und die Arbeiterbewegung*. Festgaben für Wilhelm Lexis, Jena, pp. 249-50.

⁸Bebel, August. 1961. Aus meinem Leben. 3rd East German ed., Dietz Verlag, Berlin, p. 119; Bericht über die Verhandlungen des dritten Vereintags deutscher Arbeitervereine abgehalten zu Stuttgart am. 3., 4., und 5. September 1865. Druck der Vieling'schen Buchdruckerei (Dietz), Nuremberg, 1865, p. 54.

⁹Adler, Georg. 1885. Die Geschichte der ersten sozialpolitischen Arbeiterbewegung in Deutschland. Breslau, p. 300.

¹⁰Mayer, Die Lösung der deutschen Frage. . . Op. cit., pp. 247-48.

¹¹Seeber, Gustav. 1970. Wahlkämpfe, Parlamentsarbeit und revolutionäre Politik. Zur Entwicklung der revolutionären Parlamentstaktik in Deutschland. In Deutsche Akademie der Wissenschaften. Zentralinstitut für Geschichte. Marxismus und die deutsche Arbeiterbewegung. Dietz Verlag, Berlin, pp. 223-24. Eyck, Erich. 1904. Der Vereinstag deutscher Arbeitervereine. Dietz Verlag, Berlin, I, 27.

¹²Vorobjova, A.K. 1961. Aus der Geschichte der Arbeiterbewegung in Deutschland und des Kampfes von Karl Marx und Friedrich Engels gegen Lassalle und das Lassalleanertum 1862-64. Aus der Geschichte des Kampfes von Marx und Engels für die proletarische Partei. Dietz Verlag, Berlin, pp. 288-89.

¹³Mehring, Franz. 1903. Die Leipziger Arbeiterbewegung 1862-67. Die Gründung der Deutschen Sozialdemokratie. Verlag der Leipziger Buchdruckerei, Leipzig, pp. 29-31; Bebel, *Aus meinem Leben*, pp. 89 and 93.

¹⁴Marx to Engels, February 13, 1865. Marx-Engels. Historisch-kritische Gesamtausgabe. Werke, Schriften, Briefe. ed. by V. Adoratsky. Part 3: Marx-Engels Briefwechsel. Dietz Verlag, Berlin, 1929-31, III (3), 236. Liebknecht claimed that it had been due to him alone that the ADAV had at least refused formal alliance with Bismarck. Liebknecht to Marx, February 1865. In Eckert, Georg. 1963. Wilhelm Liebknechts Briefwechsel mit Karl Marx und Friedrich Engels. Martinus Nijhoff, The Hague, p. 43.

¹⁵Leidigkeit, Karl-Heinz. 1957. Wilhelm Liebknecht und August Bebel in der deutschen Arbeiterbewegung 1862-69. Rütten und Loening, Berlin, pp. 12 and 58.

¹⁶Marx-Engels-Lenin-Stalin. 1954. Zur deutschen Geschichte. Aus Werken, Schriften und Briefen, II (1): Das 19. Jahrhundert. Dietz Verlag, Berlin, 840.

¹⁷Liebknecht to Engels, August 30, 1865. Eckert, Liebknechts Briefwechsel mit Marx und Engels, p. 60.

¹⁸Engels to Marx, November 16, 1864. Marx-Engels Briefwechsel, ed. by Adoratsky, Part III (3), 203.

¹⁹Engels to Marx, February 10, 1866. Marx-Engels Briefwechsel. ed. by Marx-Engels-Lenin Institute. Moscow, 1935, III, 20.

- ²⁰Höhn, Reinhard. 1959. Sozialismus und Heer, I: Heer und Krieg im Bild des Sozialismus. Verlag f. Wissenschaft, Berlin and Zurich, p. 20.
- ²¹Liebknecht's article in Deutsches Wochenblatt, June 24, 1866.
- ²²Höhn, Sozialismus und Heer, I, 48, 50-55, 69, 122, 125.
- ²³Conze, Werner and Dieter Groh. 1966. Die Arbeiterbewegung in der nationalen Bewegung. Die deutsche Sozialdemokratie vor, während und nach der Reichsgründung. E. Klett, Stuttgart, p. 68.
- ²⁴Mayer, Die Lösung der deutschen Frage. Op. cit., p. 259; Bebel, Aus meinem Leben, p. 160.
- ²⁵Engels to Marx, May 9, 1866. Marx-Engels Briefwechsel. Moscow, 1935, III, 395.
- ²⁶Stepanova, E.A. 1958. Friedrich Engels. Sein Leben und Werk. Dietz Verlag, Berlin, p. 124.
- ²⁷Höhn, Sozialismus und Heer, I, 183, 228.
- ²⁸Bebel, Aus meinem Leben, pp. 144-45, 151; Bebel. 1970. Ausgewählte Reden und Schriften, ed. by Rolf Dlubek and Ursula Herrmann. I: 1863-1878. Dietz Verlag, Berlin, p. 13.
- ²⁹Bebel, Aus meinem Leben, p. 150.
- ³⁰Ibid.
- ³¹Mayer, Die Lösung der deutschen Frage. Op. cit., p. 252.
- ³²Höhn, Sozialismus und Heer, I, 229.
- ³³Program is in Deutsches Wochenblatt, June 24, 1866.
- ³⁴Q.v. Bebel's testimony of March 11, 1872. Leidigkeit, Karl-Heinz (ed.). 1960. Der Leipziger Hochverratsprozess vom Jahr 1872. Dietz Verlag, Berlin, p. 44.
- ³⁵Liebknecht to Engels, December 11, 1867. Quoted in Mayer, Engels, II, 161.
- ³⁶Liebknecht's article in Oberrheinischer Kurier, November 1, 1865.
- ³⁷Liebknecht's article in Oberrheinischer Kurier, July 3, 1866; Benser, Zur Herausbildung der Eisenacher Partei, pp. 97-99.
- ³⁸Engels to Marx, July 27, 1866. Marx-Engels Briefwechsel. ed. by Adoratsky, Part III (3) 350-51; Engels to Marx, November 5, 1867. Ibid., p. 442.

³⁹Marx to Engels, September 10, 1869. Marx-Engels Briefwechsel. ed. by Institut für Marxismus-Leninismus. Dietz Verlag, Berlin, 1950, IV, 263.

⁴⁰Engels to Marx, July 25, 1866. Marx-Engels Briefwechsel. Moscow, 1935, IV, 418; Engels to Marx, October 22, 1867. Ibid., p. 521; Engels to Marx, October 22, 1867. Ibid., p. 521; Engels to Marx, December 19, 1867. Ibid., p. 533; Engels to Marx, December 8, 1867. Marx-Engels Briefwechsel. ed. by Adoratsky, Part III (3), 458-59; Engels to Marx, December 19, 1867. Ibid., pp. 465-68.

⁴¹Ebersold, Günther. 1963. Die Stellung Wilhelm Liebknechts und August Bebel's zur deutschen Frage 1863-70. Univ. of Heidelberg diss., pp. 151-54.

⁴²Schweitzer, Johann Baptist von. 1912. Politische Aufsätze und Reden. ed. by Franz Mehring. Dietz Verlag, Berlin, pp. 154-55.

⁴³Schweitzer's articles in the Sozial-Demokrat, June 6, 1866, November 30 and December 5, 1866.

⁴⁴Sozial-Demokrat, December 30, 1866.

⁴⁵Bebel's speech of April 10, 1867. Sitzung des konstituierenden Reichstags des Norddeutschen Bundes, I, 678.

⁴⁶Ibid.

⁴⁷Ibid.

⁴⁸Ibid., p. 679.

⁴⁹Bebel's speech of September 24, 1867. Ibid., II, 84.

⁵⁰Liebknecht's speech of October 17, 1867 in Ibid., II, 450-51.

⁵¹Liebknecht to Engels, December 11, 1867. Eckert, Liebknechts Briefwechsel mit Marx und Engels, p. 82.

⁵²Ibid., pp. 82-3.

⁵³Cf Leidigkeit (ed.). Der Leipziger Hochverratsprozess, p. 339, which presents Liebknecht's statement of April 3, 1872 as to the social democratic attitude towards revolution.

⁵⁴See the protest of the opposition in Bericht über den fünften Vereinstag der deutschen Arbeitervereine am 5., 6., und 7. September 1868 zu Nürnberg. Druck von C. Vollrath, Leipzig, 1868, pp. 16-17.

⁵⁵Liebknecht to Engels, December 11, 1867. Eckert, Liebknechts Briefwechsel mit Marx und Engels, p. 84.

⁵⁶Mayer, Die Trennung der proletarischen von den bürgerlichen Demokratie. Op. cit., pp. 40, 43; Vrona, Vera. 1968. Die theoretisch-weltanschauliche Entwicklung August Bebels. Zeitschrift für Geschichtswissenschaft. 16: 348-49; Hochdorf, Max. 1932. August Bebel. Geschichte einer politischen Vernunft. Verlag für Kulturpolitik, Berlin, p. 72; cf Leidigkeit, Liebknecht und Bebel, p. 91.

Blast Furnace Operations

BLAST FURNACE OPERATIONS WITH THE USE OF THE WARRIOR BASIN AND BLUE CREEK BASIN STRIP MINE COALS IN METALLURGICAL COKE

Robert E. Cooper
and
Leonard G. Allen
Blast Furnace Division
Fairfield Works, United States Steel Corporation
Fairfield, Alabama

INTRODUCTION

The shortage of available underground coal required the addition of Warrior Basin and Blue Creek Basin strip mine coals to the coke blends at United States Steel's operations in Fairfield, Alabama. The strip mine coals were blended with underground coals from West Virginia and Alabama for coking, and the use of this coke in the iron blast furnaces resulted in a dramatic change in hot metal production.

EFFECT OF STRIP MINE COALS

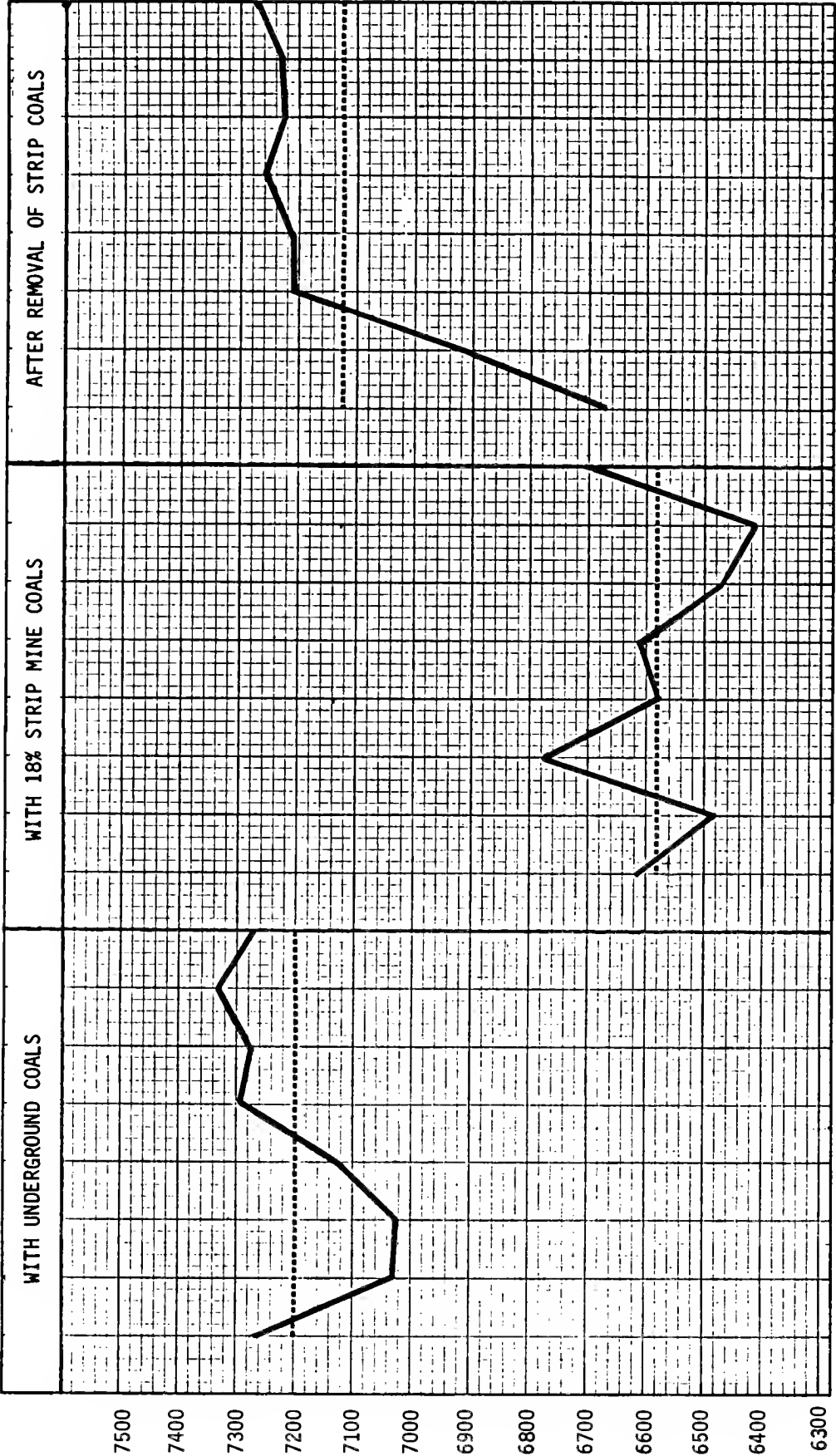
While using only the underground coals in the coke batteries, the daily production of the Fairfield Works blast furnaces was 7210 tons/day. When the addition of the strip mine coals accounted for 18% of the coking blends, the production dropped to 6580 tons/day. This loss of production was, obviously, very detrimental and the strip mine coals were removed from the coke blends. An immediate increase in production was observed with the daily production reaching 7120 tons; these production rates are displayed in Figure 1. As there were no other changes in operating practices of the blast furnaces during this period, the strip mine coals became the subject of investigation.

The investigation of the strip mine coals revealed that they were detrimental to the physical quality of blast furnace coke because of the following reasons:

1. These strip mine coals are very susceptible to oxidation due to the proximity of the seams to the surface of the earth.
2. The strip mine coals contained excessive amounts of fusain, bone, and other undesirable impurities.

While the elimination of strip mine coals from blast furnace coke blends appeared to be advisable, the coal supply shortage indicated the need for methods to successfully include them into the coke blends. An ensuing study revealed that strip mine coals could be used in the blends without adversely affecting blast furnace production if the following procedures were implemented:

1. The proper quantity and quality of sampling at the stripping operation is necessary to detect oxidized coal and to prevent its inclusion in the coke blend.
2. The detrimental effects of the fusain, bone, and impurities can be minimized by the proper pulverization levels of the strip mine coals. This pulverization level must be consistent with all the coals used in the blends.



TEST PERIOD 3

TEST PERIOD 2

TEST PERIOD 1

FIGURE 1. Blast furnace production rate vs. coke blend.

Blast Furnace Operations

3. The strip mine coals must be blended with the other coals by a consistently uniform method.

There can be little doubt that the strip mine coals used at Fairfield Works are detrimental to blast furnace quality unless proper processing is implemented prior to the use of the coals in the coke batteries. This processing can insure the continued use of the Warrior Basin and the Blue Creek Basin strip mine coals in the production of a quality metallurgical coke needed to maintain the economical operation of blast furnaces.

ENVIRONMENTAL LAND-USE APPLICATIONS FROM SPACE RESEARCH

Charles T. N. Paludan
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

INTRODUCTION

One of the most valuable aspects of the space program has been the observation of the earth. While this was predicted by military reconnaissance (Katz, 1959), the weather satellites and Mercury flights in 1962 and 1963 created the initial impact on the earth science community. This led to the establishment in 1964 of a concentrated effort by NASA and other agencies - now known as the Earth Resources Survey (ERS) Program. The ten Gemini missions in 1965-1966 produced over 2400 color photographs (Lowman and Tiedmann, 1971). An aircraft remote sensing program was also established to provide early information and to supplement the orbital data (Badgley *et al.*, 1968). The RB-57F shown in Figure 1 has been the highest altitude airplane (19 kilometers - over 60,000 feet) in the program until recently when two U-2 aircraft were added. An unmanned satellite program was established and the first experimental version of it, known as the Earth Resources Technology Satellite - Mission 1 (ERTS-1), was launched July 23, 1972. The Apollo Program has also yielded some earth studies, especially the Apollo 9 earth-orbital mission in March, 1969 (Colwell *et al.*, 1970). An analysis of part of the Apollo 9 coverage in Alabama was performed by the Geological Survey of Alabama (Powell, *et al.*, 1970).

Marshall Space Flight Center (MSFC) has a history of activities in remote sensing. Many of the techniques used in the Saturn vehicles and earlier rockets involved remote detecting instruments, film cameras, television communication equipment, and aids to data analysis (Paludan and Escue, 1967). A number of these activities led to Supporting Research and Technology studies and design. A letter from Dr. George M. Low, then Acting Administrator of NASA, in November, 1970 and the activity at MSFC's Mississippi Test Facility led to a new emphasis. Dr. Low's letter encouraged each NASA center to work with their neighboring regions to apply NASA technology to pressing local problems. A new office, the Environmental Applications Office, has been established at MSFC to aid the emphasized program.

The MSFC approach might best be summarized by mention of four points: (1) Already-developed aerospace techniques are applied to community problems, (2) NASA does not define the problems; potential users are sought out in the community and asked to define problems, (3) MSFC is applying the extensive in-house employee capability, and (4) since it is a limiting factor, MSFC is applying its broad background in data management to the program.

DEMONSTRATION PROJECTS

Growing out of earlier Technology Utilization work, MSFC has been engaged in a number of Environmental Applications Demonstration Projects for over a year. Emphasis has been on application of aerospace technology

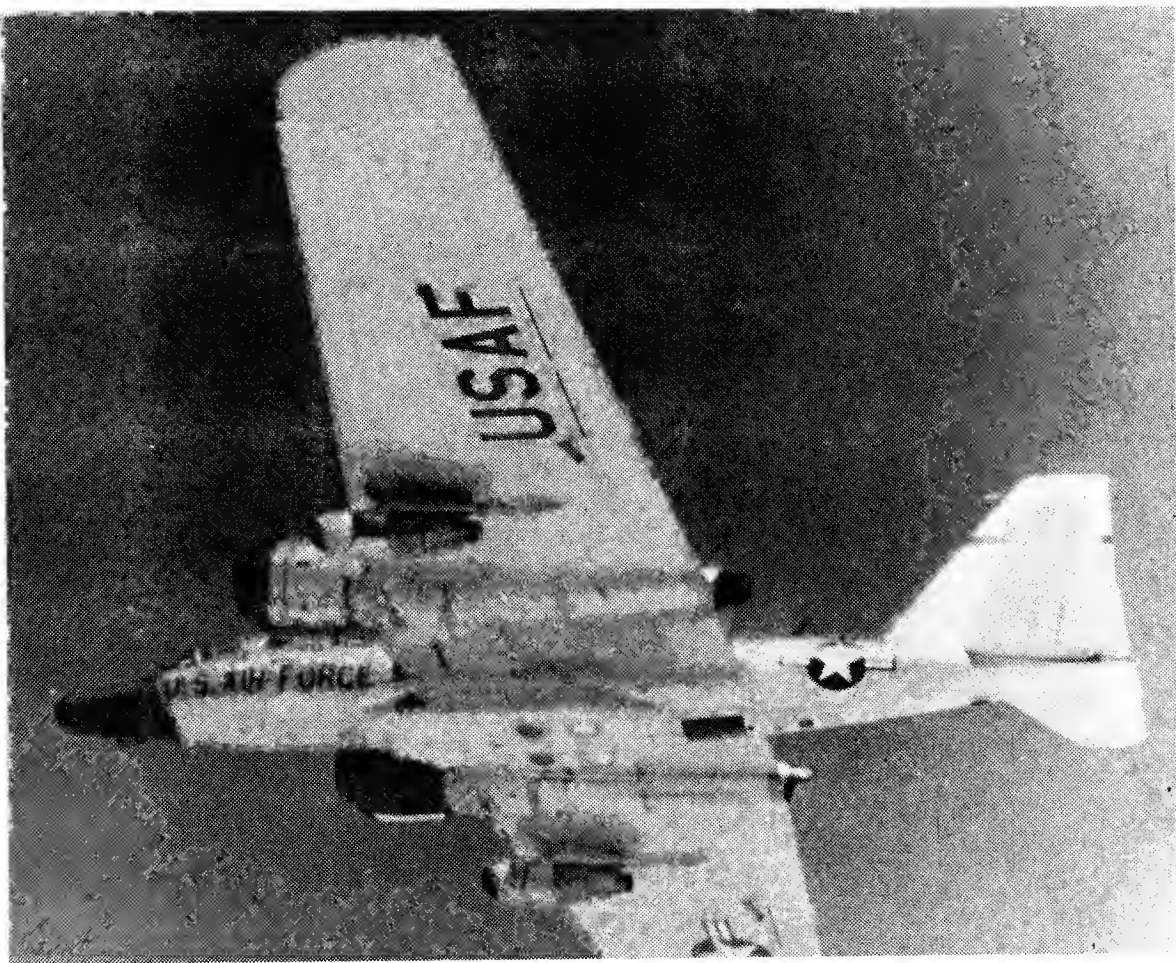


FIGURE 1. Earth Resources RB-57F Aircraft (MSFC-71-MS-G-2515).

to community needs of Southeastern U.S. (Some of these applications fall in disciplines other than Earth Resources.) The following is an incomplete list of typical Earth Observations Demonstration Projects which are under way at the present time:

Hydrological Parameter Determination

Agricultural Stress Detection

New Community Site Survey

Urban Transportation Studies

Urban Environmental Quality

Land-Use Survey

Illustrations on each of these are given below, but this paper will concentrate on the land-use survey as an important example.

Hydrology

One of the best instrumented river basins on earth is the Tennessee Valley, in which MSFC is centrally located. This has made natural several cooperative studies with TVA, University of Alabama in Huntsville, IBM, and others to apply remote sensing techniques to determination of hydrological parameters.

Agriculture

During the summer of 1971, MSFC began study of an agricultural problem in North Alabama. Chandler Mountain, near Gadsden, has over 1,000 hectares of tomatoes, many of which are affected by nematodes. In Figure 2, the farm numbered 1 lost at least \$20,000 worth of tomatoes while farm number 7B, operated by a young man using good practices, thrived.



FIGURE 2. Nematode stress in tomatoes.

New Community Site

Senator Sparkman asked MSFC to assist the Office of Housing and Urban Development (HUD) and the Tuskegee Alumni Housing Foundation (TAHF) in the study of a proposed new community site near Birmingham. Two geologists from MSFC have conducted ground surveys, and multispectral photography has been gathered to aid in planning. Figure 3 is a land-use map of the area. The area has scenic beauty with rolling hills. However, many of the hills are mine tailings, and Five-Mile Creek, which flows through the area, is heavily polluted by industrial waste.

Urban Studies

Location of MSFC's Michoud plant in New Orleans has led to cordial relations with the planning people there. They are concerned with urban environmental quality, especially as affected by traffic. The stereo overlap of RB-57 photography results in time-lapse data of the type shown in Figure 4, which can be analyzed. The amount of analysis will be large, but MSFC's in-house research in optical processing shown in Figure 5 is producing results. Data taken from the Goodyear blimp before the Super Bowl football game in January, 1972 has been analyzed in this facility. Remote sensing from aircraft is useful in the study of urban problems, and the expansion of research in this area is expected during the coming year. In addition to traffic analysis, remote sensing is useful in the determination of a number of indicators of urban environmental quality. Urban land-use studies are also possible (Paludan, 1970).

Land-Use

One identified local user/partner is the Top of Alabama Regional Council of Governments--TARCOG, five counties in Northeastern Alabama in which MSFC's main campus is located. The Top of Alabama Region is shown in Figure 6. TARCOG requested help in getting information on the most basic of planning tools - an up-to-date study of present land-use. MSFC had some prior experience in land-use study by means of multispectral photography (Paludan, 1970), and during the summer of 1971 data were collected on the entire 10,000 km² area. This is now being converted into maps at the 1:24,000 scale. An example, the Tanner Quadrangle, is shown in Figure 7. It will soon be published by the Tennessee Valley Authority. Ground truth support is provided by Alabama A&M University.

Multispectral photography is a technique of simultaneously exposing several photographs of the same scene, but each in a different and relatively narrow portion of the color spectrum. This is accomplished by means of a group of cameras - a method used on Apollo 9 - or by a multi-lens camera such as that shown in Figure 8. Each lens is combined with a different color filter. Film used is usually black and white, and is often of a type sensitive to the near infrared light as well as visible colors. A chart of spectral qualities of the film and filters used is shown in Figure 9. The processed film will contain sets of images, as shown in Figure 10. These may be studied in this form, but analysis is greatly aided by use of a "color additive viewer" - shown in Figure 11 - which permits simultaneous projection of each image onto a single screen. Each projection can be varied in intensity and in color of projector light, so

that true color or false color composite images can be created. Certain aspects of vegetation, soils, and general land-use can be enhanced or suppressed by manipulation of the viewer controls (Colwell, 1966).



FIGURE 3. Land-use map of the TAHF Area.

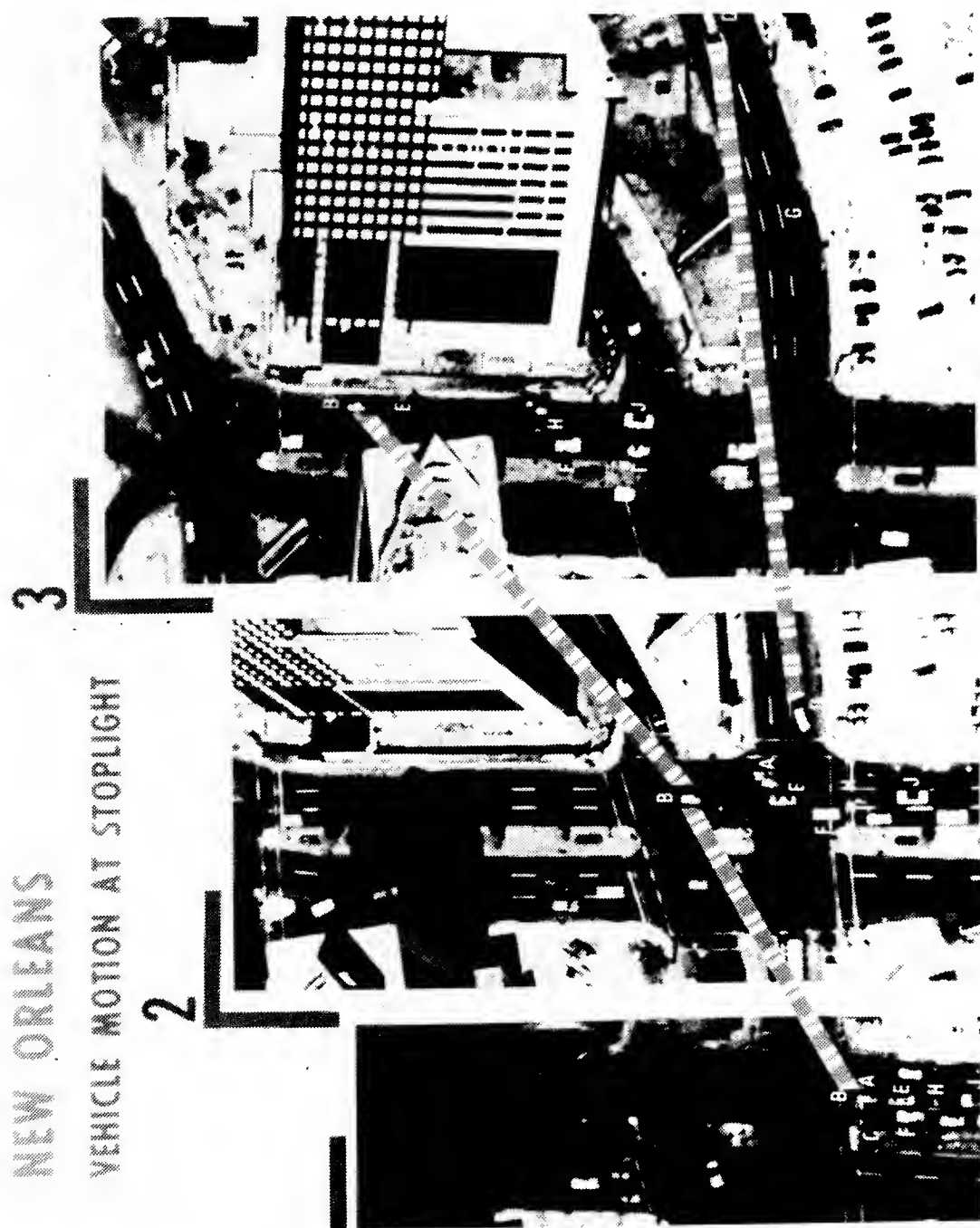


FIGURE 4. Time-lapse traffic study.

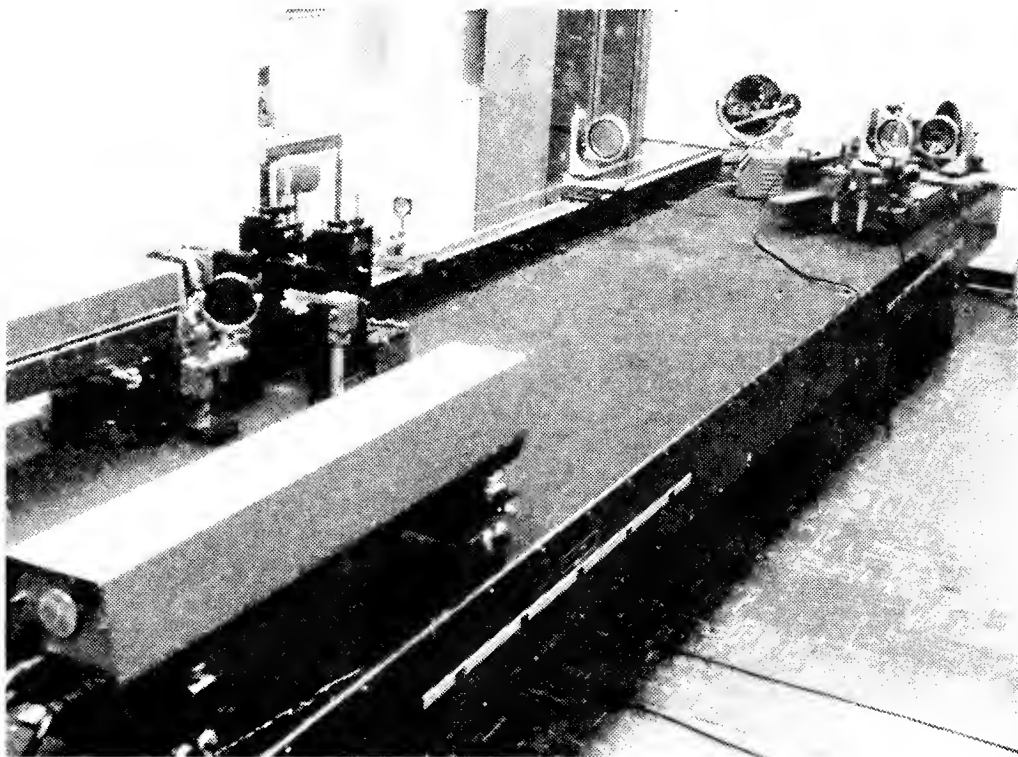


FIGURE 5. Optical processor.

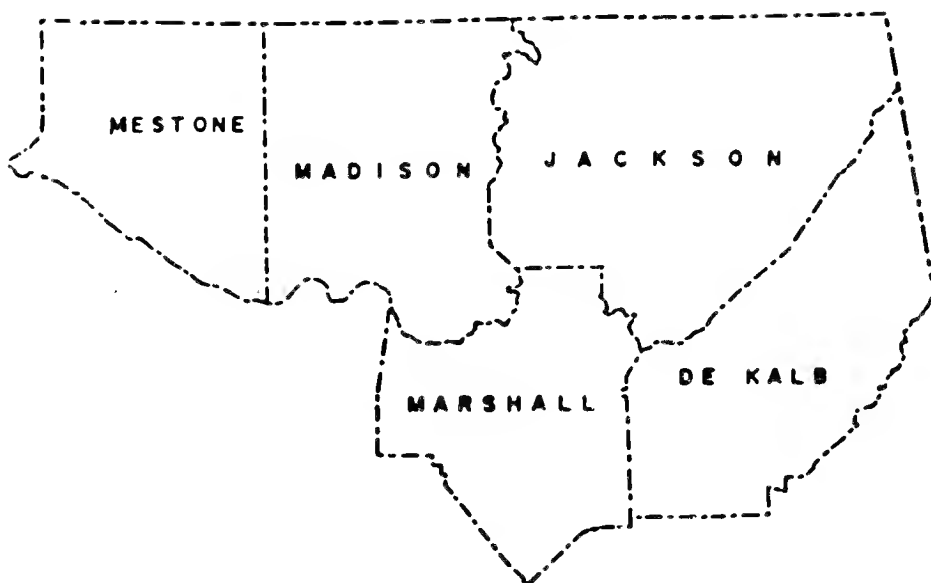


FIGURE 6. Top of Alabama Region.

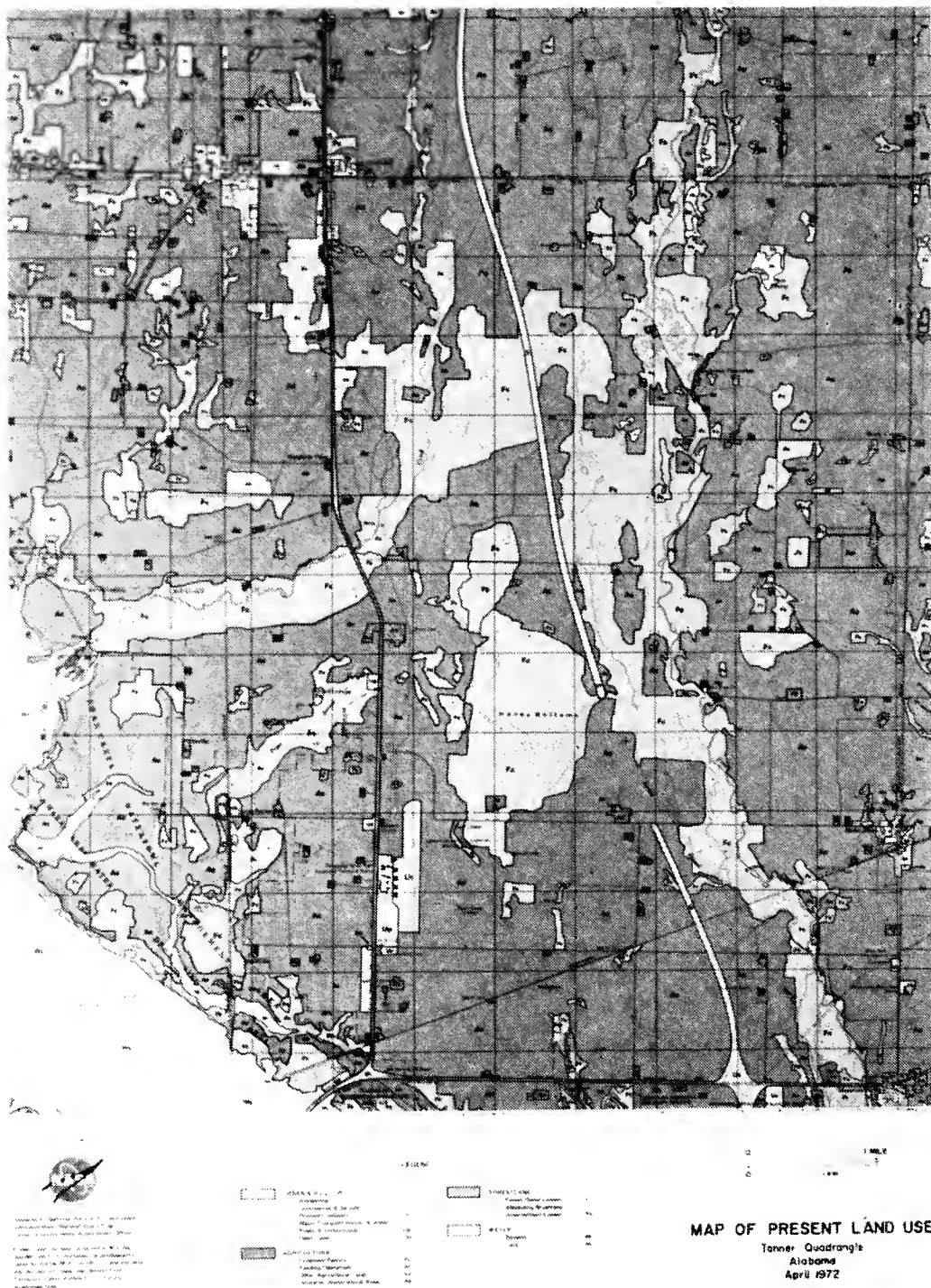


FIGURE 7. Land-use map of the Tanner Quadrangle.

The multispectral technique is particularly effective for rural land-use determination. Detailed land-use maps are rare in the United States because conventional field methods for data-gathering are slow and expensive and land-use changes rapidly, especially near urban areas. Of the states, only New York has completed a state-wide land-use survey (Swanson, 1969). New York used conventional black and white aerial photographs. Results to date confirm MSFC's belief that multispectral photography is more effective and permits large regions to be mapped quickly. Two important aspects of land-use surveys - choice of classification system and choice of locational grid (Colvocoresses, 1967) - have been considered from the viewpoint of national standards.

A comprehensive history of U. S. land-use studies has been published by Resources for the Future, Inc. (Clawson, 1965). In 1949 the International Geographical Congress established a Commission on World

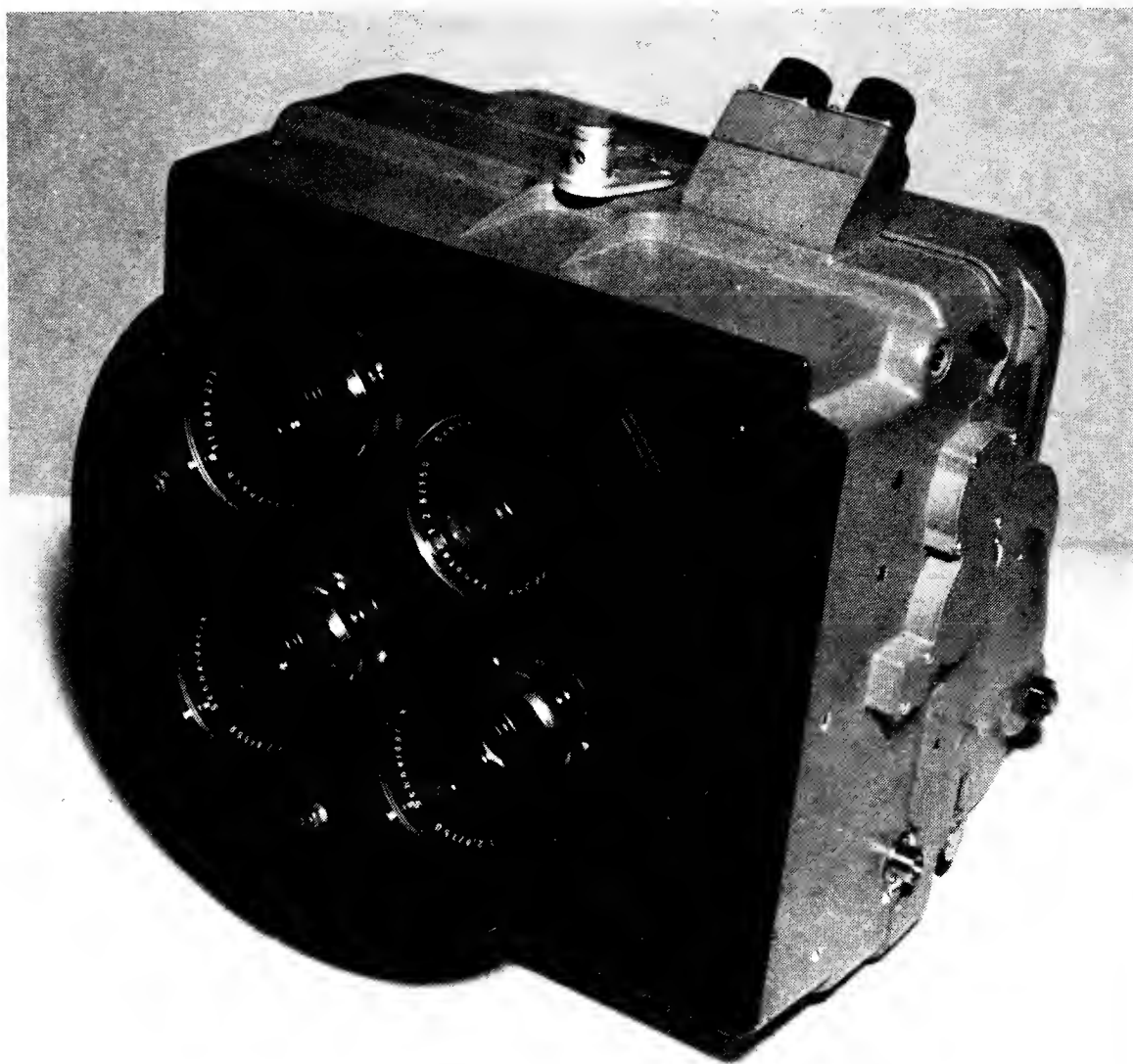


FIGURE 8. Multispectral camera.

MSFC MULTISPECTRAL CAMERA

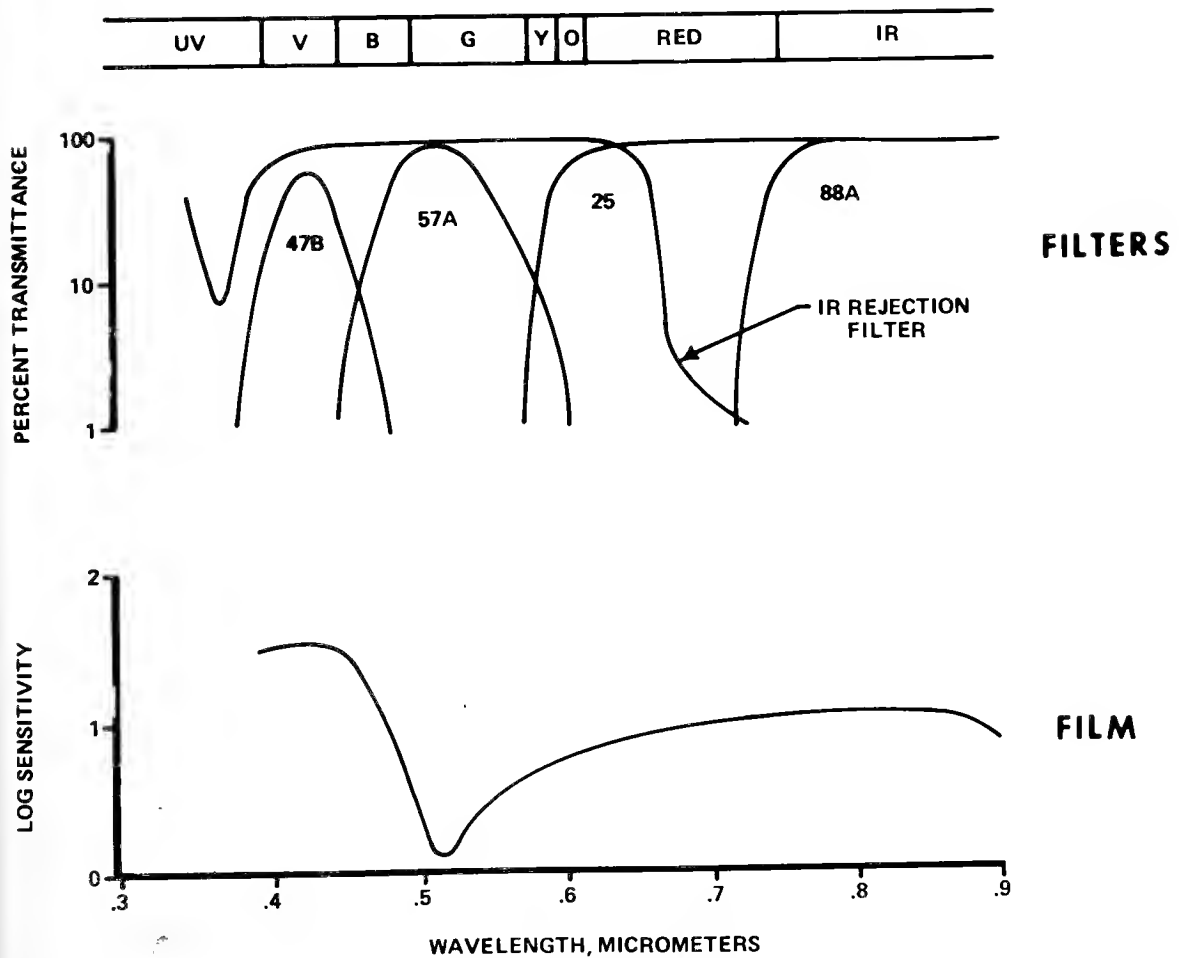


FIGURE 9. Film and filter characteristics.

Land Use Survey (International Geographical Union, 1952). A classification system was established with nine color-coded categories. The only complete, national contribution of large size using this scheme is the Second Land Utilisation (sic) Survey of Britain (Coleman, 1968).

The advent of remote sensing has required a new look at classification systems. The only existing U. S. standard was primarily for urban areas and was not well suited to aircraft or space-acquired data (Urban Renewal Administration, 1965). The Commission on Geographic Applications of Remote Sensing of the Association of American Geographers has studied this problem and proposed some tentative classification schemes (Anderson, 1971). In June 1971, NASA and the Department of Interior co-sponsored a conference on this subject, and a new national standard on land-use classification will probably emerge (Gerlach, 1972). MSFC has adopted the proposed scheme, as it is presently envisioned - shown in Figure 12. An expanded version of the scheme has also been adopted by the State of Alabama (Alabama Development Office, 1972).

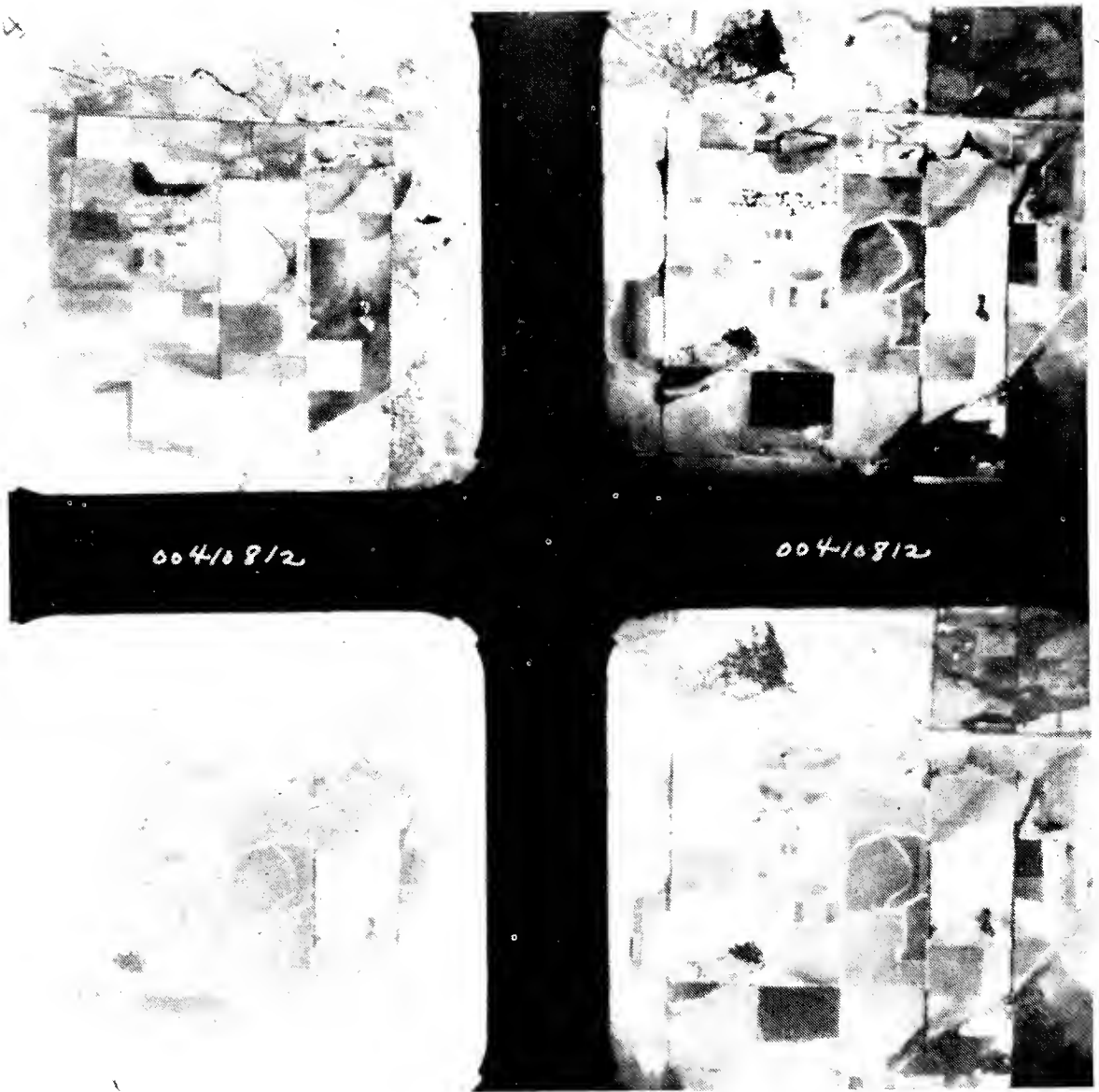


FIGURE 10. Example of multispectral image set.

ERTS and Skylab

MSFC is involved in ERTS (Figure 13) and the Skylab Earth Resources Experiment Package (EREP) (Figure 14) from a number of viewpoints:

Co-investigator, State of Alabama ERTS Proposal

Data Management Working Group

Scientific Monitors for ERTS Experiments

Data Compression Experiment for EREP

Proposal Evaluation Panels

User Identification in Southeastern States

Information System Studies



FIGURE 11. Color additive viewer.

Mississippi Test Facility

MSFC's Mississippi Test Facility (MTF) is an important part of MSFC's involvement. It supports a number of co-located on-site activities by other agencies, and has close ties with users in the region. This facility is considered as a test bed for the long range involvement of NASA in environmental activities with other agencies of federal, state and local governments, as well as an excellent model of a regional center for data analysis and dissemination. Regional modeling is a key activity at MTF, and among the most interesting long range goals is the development of models of the states of Mississippi, Louisiana, and Arkansas. From these models, the total impact on the region can be determined for any proposed project. Such models will be of particular utility to planning groups and to the state legislatures. The information for these models will come from the agencies located at MTF, including the NASA Earth Resources Laboratory. An interesting remote sensing study of the MTF and nearby area was published by the U.S. Geological Survey (Department of the Interior, 1970).










SYMBOL		COLOR
URBAN & BUILT-UP	U	RED
RESIDENTIAL	Ur	
COMMERCIAL & SERVICES	Uc	
PRIMARILY INDUSTRY	Ui	
EXTRACTIVE	Ue	
MAJOR TRANSPORT ROUTES & AREAS	Ut	
PUBLIC & INSTITUTIONAL	Up	
OPEN LAND	Uo	
AGRICULTURAL	A	LIGHT BROWN
CROPLAND/PASTURE	Ac	
ORCHARDS, VINEYARDS, GROVES, BUSHFRUIT, INCLUDING HORTI-	Ah	
CULTURAL AREAS	At	
FEEDING OPERATIONS	Ao	
OTHER AGRICULTURAL LAND		
RANGELAND	R	ORANGE
RANGELAND	R	
FORESTLAND	F	GREEN
FOREST (SOLID CROWN)	Fc	
AForesting BRUSHLAND (INTERMITTENT CROWN)	Fb	
ARID WOODLAND	Fa	
TREE PLANTATIONS	Fp	
WATER	W	LIGHT BLUE
STREAMS	Ws	
LAKE	Wl	
RESERVOIR	Wr	
COASTAL & ESTUARY WATERS	Wc	
NON-FORRESTED WETLAND	M	DARK BLUE
VEGETATED	Mv	
BARE	Mb	
TUNDRA	T	GREY
TUNDRA	T	
BARREN LAND	B	
BEACHES	Bb	
EXPOSED ROCK	Br	YELLOW
TAILINGS, ABANDONED PITS & QUARRIES	Bt	
SALT FLATS	Bh	
LAVA FLOWS	Bl	
SAND (OTHER THAN BEACH)	Bs	
OTHER	Bo	
PERMANENT SNOW & ICE FIELDS	S	WHITE
PERMANENT SNOW & ICE FIELDS	S	

FIGURE 12. Land-use classification scheme.

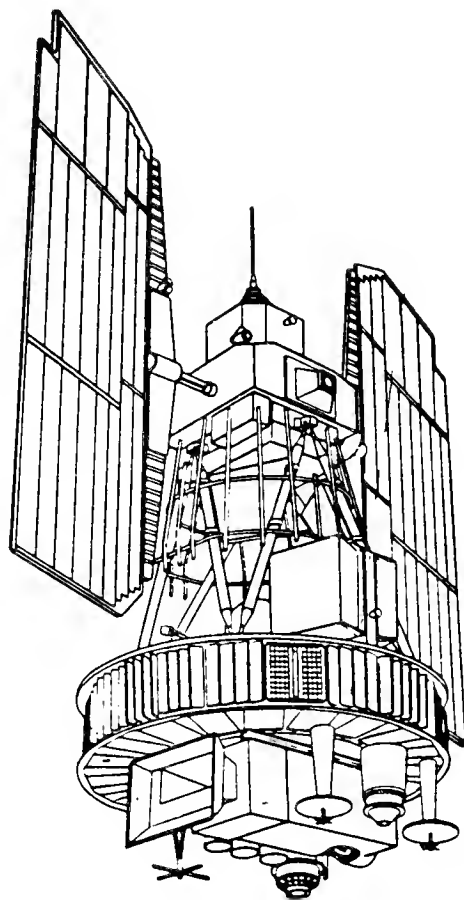


FIGURE 13. ERTS.

SUMMARY AND INVITATION

The NASA Earth Resources Survey Program has much to offer in data and information to a broad spectrum of users. The greatest short-coming in the program at present is the lack of detailed working arrangements with many regional, state, and local agencies and individuals who have pressing needs for earth survey information. A primary intent of MSFC's involvement in the program is to encourage potential partners in Alabama and other Southeastern states to make their needs known, to assist them in obtaining data, and to assist initially in analysis of data to produce useful information. MSFC has initiated demonstration projects to serve as examples of the type of partnership available, and a "user workroom" is available at MSFC-Huntsville for use by anyone who needs data, or who wishes to see a demonstration of the techniques. MSFC-MTF in Southern Mississippi offers the same service, especially for the states of Mississippi, Louisiana and Arkansas.

REFERENCES

- Alabama Development Office, "Alabama Standard Land Use Classification," *Planner's Mapping and Classification Guide*, Montgomery, 1972.
- Anderson, J. R., "Land-Use Classification Schemes," *Photogrammetric Engineering*, Vol. 37, April 1971, pp. 379-387.

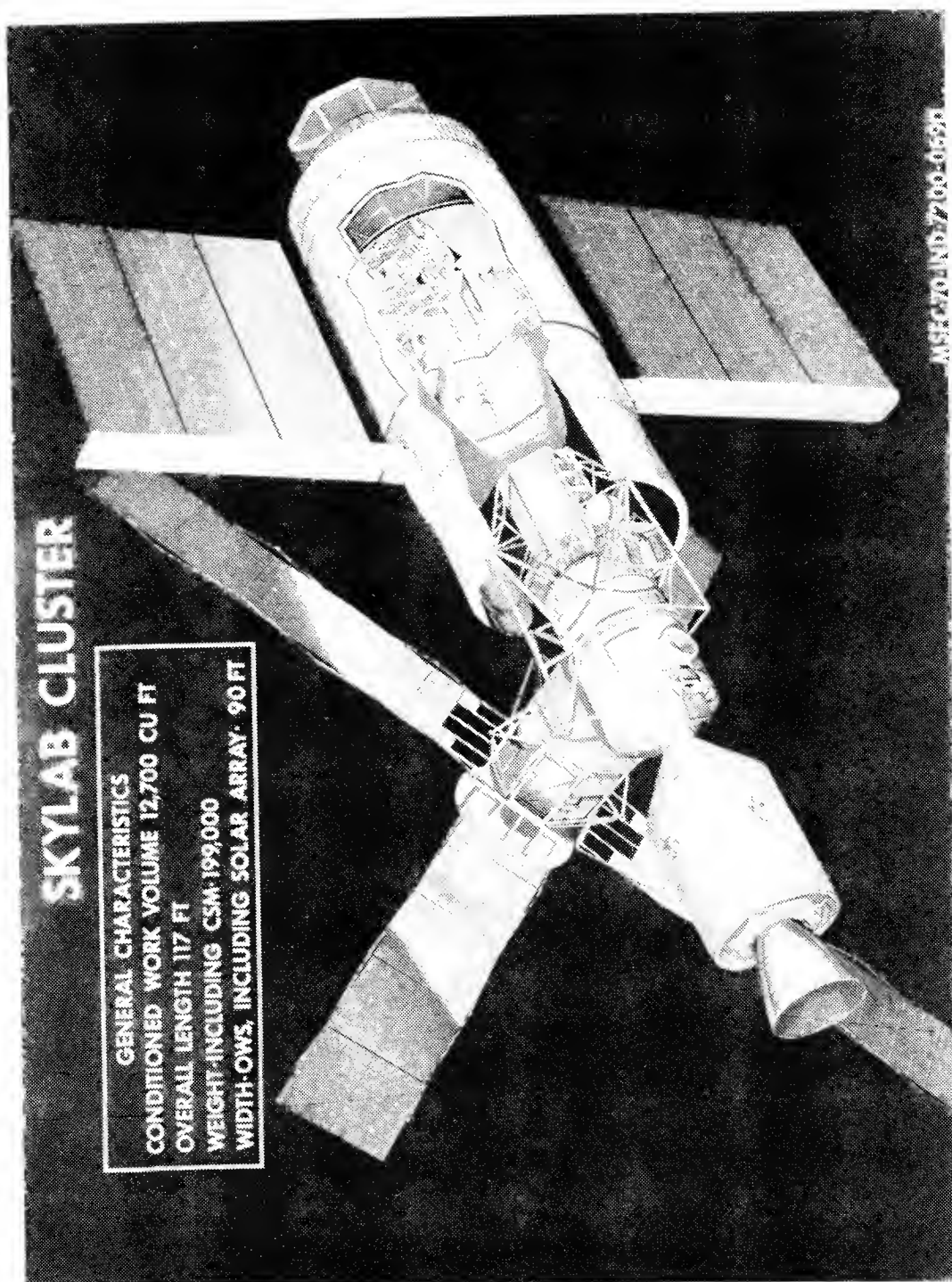


FIGURE 14. Skylab.

- Badgley, P. C., Colvocoresses, A. P., and Centers, C. D., "NASA Earth-Sensing Space Flight Experiments," *Photogrammetric Engineering*, Vol. 34 (February 1968), pp. 163-167.
- Clawson, M., *Land Use Information*, Baltimore, The John Hopkins Press, 1965, 402 pp.; history of land-use study is in Chapter V, pp. 55-81.
- Coleman, A., *Land Use Survey Handbook*, The Second Land Use Survey, King's College, Strand, London, 1968, 32 pp.
- Colvocoresses, A. P., "A Unified Plane Coordinate Reference System," *Surveying and Mapping*, Vol. 27 (December 1967), pp. 621-624.
- Colwell, R.N., "Uses and Limitations of Multispectral Remote Sensing," *Proceedings of the Fourth Symposium on Remote Sensing of Environment*, Ann Arbor, April 1966, pp. 71-100.
- Colwell, R.N., Lowman, P.D., and Wenderoth, S., *Apollo 9 Multispectral Photographic Information*, Manned Spacecraft Center, NASA TM-X-1957, April 1970.
- Department of the Interior, *Environmental Conditions and Resources of Southern Mississippi*, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., February 1970, 58 pp; map.
- Gerlach, A. C. (ed), *Conference on Land Use Information and Classification*, Conference Papers, U. S. Geological Survey, 1972.
- International Geographical Union, *Report of the Commission on World Land Use Survey for the period 1949-1952*, Worcester, The Commonwealth Press, 1952.
- Katz, A. H., "Observation Satellites: Problems and Prospects," The RAND Corporation, P-1707, May 1959; also published serially in *Astronautics*, April, June, July, August, September, and October, 1960.
- Lowman, P. D., and Tiedemann, H. A., *Terrain Photography from Gemini Spacecraft: Final Geologic Report*, Goddard Space Flight Center, Greenbelt, Maryland, Report X-644-71-15, January, 1971.
- Paludan, C. T., and Escue, W. T., "Remote Sensing of Phenomena on the Saturn Vehicle," *Proceedings of the 1967 National Telemetering Conference*, San Francisco, May 16-18, 1967.
- Paludan, C. T., "Potential Contributions of Orbital Earth Resources Data to Urban Planning," *Planning Challenges of the 70's in Space*, Tarzana, Calif., American Astronautical Society, 1970, pp. 373-382.
- Powell, W. J., Copeland, C. W., and Drahovzal, J. A., *Delineation of Linear Features and Application to Reservoir Engineering Using Apollo 9 Multispectral Photography*, Geological Survey of Alabama Information Series 41, 1970.

Swanson, R.A., *The Land Use and Natural Resources Inventory of New York State*, Albany, N.Y., State Office of Planning Coordination, Staff Paper, June, 1969.

Urban Renewal Administration and Bureau of Public Roads, *Standard Land Use Coding Manual*, Washington, Government Printing Office, 1965.

Do Consumers Know Anything?

DO CONSUMERS KNOW ANYTHING?

E. H. Bonfield and Samuel H. Himes, Jr.
Department of Marketing
University of Alabama, University

INTRODUCTION

Many consumer advocates assert that today's consumer is almost helpless in the marketplace. Advertisers daily aim thousands of messages toward consumers, and many of these ads appear to be mutually contradictory. Consumerists contend that such conflicting claims and confusing information often make impossible the task of wise consumer decision-making in the purchase of goods and services. The authors of this paper suspect, however, that consumers know considerably more than is generally credited to them by most consumer advocates. The pilot study discussed here was designed to explore that suspicion of greater consumer knowledge.

EXPLANATIONS FOR CONSUMER KNOWLEDGE

One possible explanation for the greater-than-expected amount of consumer knowledge is Tolman's psychological concept, "latent learning." By definition, "latent learning" is any learning which is not exhibited at the time it takes place. For example, students in home management courses read textbooks giving them much information on proper methods of choosing goods and services in the marketplace. Anyone observing a student studying alone will not be able to determine the specific information which has been learned. Perhaps the student herself will be unaware that learning is taking place as she reads her textbook. But the fact this learning has taken place is exhibited on exams. Similarly, housewives read newspapers and magazines, and watch television, media which devote part of their coverage to messages aiding housewives in making rational, economic decisions in the marketplace. Some of this information is also included in advertisements appearing in these media. Knowledge gained in this manner may be infrequently exhibited by the housewife to herself, but when the occasion for its use arises the housewife-buyer may employ such knowledge.

A second explanation is simply that consumers consciously expose themselves to information which aids in making economic, rational consumer decisions and thus know more than is commonly believed. Proposals relating to documentation of advertising claims, unit pricing, and nutritional labeling may presume such characteristics in the consumer.

STUDY DESIGN

A pilot test of a 28-item, multiple-choice consumer knowledge questionnaire was developed and administered in face-to-face interviews to 76 adults selected by means of a cluster sample within a metropolitan area of over 100,000 persons. Each of the respondents said he or she was responsible for the major portion of grocery purchases in the household.

Each question had four possible answers, only one of which was correct. In the instructions, the respondents were asked to answer the following sample question:

Which of the following milk products contains the greatest proportion of cream?

The answers available for the sample question were:

- a. Half and half
- b. Skim milk
- c. Cottage cheese
- d. Homogenized milk

Immediately following the sample multiple-choice question was the word "Confidence" and the numbers "1", "2", and "3." The respondents were told:

For each question we want to know how sure you are that your answer is correct. If you are certain you picked the right answer, circle the number "1". If you are almost certain you picked the right answer, circle the number "2". If the answer is a guess, circle the number "3".

Interviewers went over the instructions and sample question with the respondent until the interviewer was certain the respondent could comply with the instructions. The rest of the questionnaire followed the sample question format and was self-administered.

The questions were selected so they differed in degree of difficulty. Success in that selection is suggested by the range of percentages of respondents indicating their answers were guesses. For example, only one respondent "guessed" correctly that "choice" was the highest grade of meat according to USDA standards from among "good," "choice," "utility," and "standard." At the other extreme, 37 of the respondents guessed the definition of "holder in due course." Slightly over 40 per cent of these respondents were correct. That is, they defined the term as a "person or firm which purchases someone's debt."

RESULTS OF THE STUDY

If latent learning was at least partially responsible for consumer knowledge, then those respondents who guessed at the answer should have chosen the correct answer at better than a chance rate. That is, they should have had the right answer more than 25 per cent of the time. Correct answers at a better-than-25 per cent rate among the guessers took place in 88 per cent of the questions. This is a strong indication that something other than chance was accounting for correct answers, particularly when many of the questions were deliberately chosen to be difficult for most people to answer. One explanation is that latent learning had taken place at some earlier time and was only then being exhibited.

Another aspect of the study concerned how much consumers actually know. For four questions, 90 per cent of the consumers selected the correct

Do Consumers Know Anything?

answers. For two questions, the correct answer was chosen by 70-89 per cent of the respondents, and 60-69 per cent of the respondents selected the correct answer on six questions. The correct answer was chosen by 20-50 per cent of the respondents on nine questions.

Other results, chosen at random include:

--Botulism, the illness that may result from failure to process canned goods at sufficiently high temperatures, was correctly identified by 96 per cent of the respondents.

--Baking soda was chosen for putting out a grease fire by 78 per cent.

--Only 20 per cent correctly selected wool as the least flammable natural fiber, while 49 per cent selected linen.

--The respondents split almost evenly on a pricing question. Forty per cent preferred a one-pound can of peaches for 23¢ while 39 per cent preferred three one-pound cans for 70¢. This suggests unit pricing might be potentially valuable to a large segment of this population.

--Some 62 per cent of the respondents knew that loose beef fat may legally be added in grinding beef into hamburger at food stores.

--Eighty-two per cent of the respondents were aware that ascorbic acid is the chemical name for Vitamin C.

--One-fourth of the respondents knew that liquid was the best type of shoe polish for hiding scuff marks on children's shoes; 40 per cent thought the answer was "paste."

--Most (92 per cent) knew that the relative cost of hospital rooms had increased more than had the cost of pulling a tooth, eyeglasses, or doctors' house calls in recent years.

--A majority of respondents (57 per cent) chose the correct answer that "no-fault" insurance referred to a situation in which a person's own insurance company would pay for his damages and personal injury resulting from an automobile accident, regardless of who caused the accident. Some 24 per cent of the respondents answered that the state would pay for the damages and personal injury of all parties, regardless of who was at fault.

--Better than half the respondents knew that the cost of operating Better Business Bureaus is paid by local businessmen, while about an equal percentage knew the Federal Trade Commission has principal responsibility among U.S. Government agencies for consumer protection. About one-fourth chose the Department of Agriculture and another quarter named the Interstate Commerce Commission.

DISCUSSION

Since many of the questions were chosen to be difficult, it is not surprising that a small percentage of respondents answered them correctly. There are instances where lack of consumer knowledge may be dangerous, as, for example, when only 20 per cent of the respondents answered that wool was the least flammable natural fiber. On the other hand, much important information does appear to be known by many of the respondent-consumers.

Finally, we should ask the question, "How much do consumers *think* they ought to know?" One measure of consumer interest might be knowledge of who the important consumer advocates are and what positions they hold. We asked the question, "Who is the President's top consumer advisor?", even

adding this person's title, the Director of the Office of Consumer Affairs. Only one-third of the respondents correctly answered Virginia Knauer. Approximately 30 per cent answered Betty Furness (who occupied a similar office in President Johnson's administration and now holds the same type of job in the New York State government), and an equal number answered her counterpart in New York City, Bess Myerson. Ten per cent of the respondents said that Ralph Nader is the President's top consumer advisor and the Director of the Office of Consumer Affairs.

In summary, the results of this pilot test suggest that the consumer has a greater degree of knowledge than is frequently expressed by consumer advocates. In some areas, however, more concentrated consumer education appears warranted. The results of this study are tentative due to the small sample size. It provides a basis for a more definitive study.

Solid Waste Collection

SOLID WASTE COLLECTION PROBLEMS

Richard M. Wyskida
Department of Industrial and Systems Engineering
University of Alabama, Huntsville

INTRODUCTION

One of the most serious shortcomings in the field of public works since World War II has been a chronic inability to evaluate the status of the art of solid waste collection and disposal and to develop logical and economical systems to meet the changing times. Although some \$4.5 billion are spent annually in the United States to collect and dispose of refuse and other solid wastes, the collection and disposal practices in common usage are but little improved over those of a quarter century ago. Much of the blame must be attributed to the very nature and origin of the problem: waste disposal has historically been delegated to the lowest levels of responsibility.

It is only too common a practice in all but the largest metropolitan areas in the United States to find solid waste management conducted through a "dirt-under-the-rug" approach. As long as refuse does not pile up in the streets or on the curbs or in the alleys, and as long as the rat-infested dump annoys only the nearby residents, matters of efficiency, economy, public health, and safety are overlooked, and the more "pressing" (and better understood) aspects of community life are studied and financed, and their programs implemented.

Solid wastes have not been accorded appropriate recognition as a national problem, unlike the liquid waste systems which require thoughtful design and construction, careful operation, and strong public support for generous funding. In the deceptive simplicity of solid waste collection and disposal operations lies the delusion.

Surveys of solid waste collection and disposal practices throughout the nation reveal very few consistencies. Often the going practices turn out to be the result of cut-and-try techniques handed down from one generation to another. For example, for many years, separate collection in the Los Angeles metropolitan area of food wastes for use as hog food continued after the economic advantage to the communities was grossly outweighed by the far greater costs of making two separate collections. In other cities outmoded collection service is provided: refuse is shoveled from vaults, leaves are pitchforked from loose piles, separate trucks are driven over identical routes for different classes of refuse, and all are deposited at the same disposal site, where an expensive incinerator was built on wastelands that could be reclaimed by sanitary landfilling (1).

The collection and disposal of domestic solid wastes often costs four to six times more per capita than the collection and disposal of liquid wastes. At the present time refuse production averages about 4.5 pounds per capita per day. Despite high cost, increasing refuse production, and mushrooming urban populations, few systematic investigations have considered refuse collection systems as challenging technical management problems (2).

Intuitively most municipal officials know that the loss of close-in disposal sites coupled with the rising cost of labor and equipment has resulted in mounting solid waste collection and disposal budgets, with little or no improvement in service rendered. While the widespread search for more efficient collection and transportation techniques is continuing, a large city struggling to keep up with the never-ceasing generation of refuse has little opportunity for exploring departures from normal operations (3).

Research in solid wastes management has been directed to the discovery of basic information; to the development of processes and technology; to the impact of waste management schemes on the air, water, and land resources; to the economics of collection and disposal; and to jurisdictional and planning problems. While the scope of past research may not be inappropriate, it has been limited by the inadequate scale of investigations and lack of effort to translate knowledge into effective systems (1).

The problems discussed in this paper relate to a computerized heuristic procedure for designing solid waste collection routes. It is a generally applicable method that is based on actual "block by block" refuse collection data, which, when properly utilized, yields near optimal routes subject to constraints imposed by the user.

This procedure goes a step farther than the methods presented in current literature on "optimal" routing of refuse collection vehicles in that it was developed from a practical application viewpoint (i.e., developing a set of refuse collection routes for the City of Huntsville, Alabama), whereas most of the current literature on the subject advocates the use of computer simulation models. While simulation models may well be used to find a set of routes theoretically, these routes will probably not stand the test when implemented. The reasons for this failure of simulation designed routes upon practical application may be: 1) Most simulation modeling studies are accomplished in an effort to avoid collecting a voluminous amount of data, hence the data must be created artificially by some means and the use of this artificial data causes an abstraction from the physical environment; and 2) In simulating the operation of a refuse collection vehicle, some method of dictating the path of the vehicle upon encountering an intersection must be incorporated into the program. This is a very difficult portion of the procedure to make general enough to negotiate many if not all of the possible situations that may arise without excessive back-tracking.

PROBLEM IDENTIFICATION AND FORMULATION

The officials of the Sanitation Department of the City of Huntsville, Alabama, began to actively seek aid in the solution of their solid waste collection problems early in the Summer of 1970. In initial consultations with the city officials, it was brought out that considerable worker dissatisfaction and inefficiency in refuse collection stemmed from the collection routing system.

Mainly due to the nearness of Redstone Arsenal, Huntsville has grown very rapidly and, as might be expected, the expansion has not been

Solid Waste Collection

homogeneous in all directions; hence, the existing routing procedure resulted from a "you take it" policy within the Sanitation Department. This "you take it" policy meant that as new streets, subdivisions, and businesses were created in the process of expansion, they were assigned to the truck and crew which had most recently been added to the collection system. Obviously this method could and did result in considerable inefficiency and worker dissatisfaction in that, for a while at least, the new truck and crew did not have a full route. However when more streets, subdivisions, or businesses were added to the collection agenda, regardless of the location of these new units, the new crew had to collect from these units in order to complete their route. Hence, this policy resulted in routes which are segmented, overlapping, and very inefficient (4).

The overall problem can be treated as a complex routing and zoning problem with several side restrictions. Usually, the disposal of the refuse is in a single area, somewhere outside the city limits (called the sanitary landfill). Given the maximum work force available and the minimum number of collection trucks, it is desired to distribute the refuse collection routes in such a manner that on the average, each truck along with its crew members (one driver and two helpers) are engaged in a fair day's work. However, in finding the routes of the trucks, it is also desired that the cost involved in refuse collection should be reduced as much as possible.

The above description of the problem leads to the following categorized formulation:

Given:

1. a single sanitary landfill location
2. the volume to be collected from each customer
3. the time required to service a particular customer type
4. the time required to unload at the sanitary landfill
5. the distance to each route location
6. the identification of each block within the collection area
7. the enumeration of customers per block
8. the identification of customer type

Determine:

1. the set of collection routes required to adequately service the specified collection area.
2. the volume of solid waste collected per route

Constraints:

1. equitable distribution of work effort ($7.5 \text{ hr} \leq \text{work day} \leq 8 \text{ hr}$)
2. three man collection crews

Assumptions:

1. collection occurs twice a week causing the usual four-three phenomena

2. routes are developed on the basis of four days between collection intervals
3. collection crews and trucks originate each morning at the sanitary landfill location
4. customer density > 50 per mile.

The given information for the problem requires an objective determination since it is improbable that the needs of the sanitation department will contain the relevant data and/or information.

The problem of finding the refuse collection routes can be treated by a technique similar to the one proposed by Bodner, et al. (2). They determined a route or path through their street grid by means of a simulated vehicle "random walking" the street network, making random decisions of the direction to turn upon arrival at each intersection, with the constraint that travel along previously serviced streets is minimized. It is entirely possible that such a procedure would be plausible for a relatively small grid network, as was the case in Potsdam; however, for large city grids, considerably more than random decisions are necessary in establishing the initial, continuous route through the grid.

SOLUTION PROCEDURE

Solid waste collection routing is accomplished by a three-step procedure. First, data are collected on each existing route and placed in the proper format on a digital computer. This permits homogeneous sections of the overall collection area to be identified with the resulting collection time values calculated. The collected data should also be classified according to collection type, such as residence, apartment, or business. This classification permits a more accurate solution procedure.

Second, a single route, which may start at the beginning of any arbitrary street, visits every customer once, and terminates at the starting point, is determined. This is the route which a truck of infinite size would traverse in satisfying the system objectives. Third, the individual collection routes are then identified based upon a "fair day's work", solid waste density, and distance from the sanitary landfill location to the individual route.

Since this effort was not to be simulation oriented, it was crucial that a valid data base be established. Hence, each route was observed in totality; that is, an individual equipped with a stop watch and the proper data forms actually rode each route with each collection crew. In this way, "actual collection time values" were obtained for each city block, from which it was possible to develop the heuristic procedure. Each route was observed at least once, with many routes observed several times to provide statistics for detailed analysis.

The most crucial value, collection time, is defined as the time the collection crew actually expends from the beginning of one block to the end of the same block, divided by the number of collections performed (4). A summary of average collection time by collection type, for the entire city, is given in Table 1. It should be noted that the city provides this collection service to 32,898 customers at least twice a week.

Solid Waste Collection

Table 1. Average collection time by collection type for the entire city.

Collection Type	Average Collection Time (Min.)
Residential	0.430
Apartment	0.220
Commercial	1.650

The values in Table 1 tend to ignore the economic capabilities of the customer. Therefore, the city was strategically divided into four major sections. However, prior to this division, it was determined that certain large businesses were receiving daily service, while most smaller businesses received only "residential type" service. Consequently, large businesses were segregated from residential, apartment and small business customers. Table 2 summarized the average collection time by collection type and city section.

TABLE 2. Average collection time in minutes by collection type for all customer routes, by city section.

Collection Type	City Section			
	1	2	3	4
Residential	0.471	0.405	0.401	0.432
Apartment	0.457	0.213	0.244	0.283
Residential Type Commercial	1.713	1.605	1.796	2.662
Daily Commercial	3.466	2.171	2.544	2.808

It is immediately apparent from the statistics in Tables 1 and 2 that considerable variation in collection time exists between collection types, and also, to a lesser degree, between city sections. The availability of the basic information in this fashion lends considerable flexibility to the procedure starting point.

The technique employed in developing the one continuous route through the grid has been entitled the "logical approach" (5). This technique requires the data for each city block to be placed upon an IBM card. Then, based upon the researchers familiarity and expertise associated with the physical layout of the city, the data were ordered into one continuous route. Natural boundaries and major thoroughfares served to compliment the previously identified city sections. Hence, at the end of each city block, the researchers visually determined, from a recent city map, the logical direction to continue the route. This

approach permitted the all important "look-ahead" feature to be incorporated into the technique. Consequently, the continuous route was continually developed with complete knowledge of forthcoming obstacles and situations. Although the continuous route developed in this fashion may not be optimal, it is very clear that an optional ordering procedure has yet to be developed.

Once the continuous route through the city grid is completely identified, the individual routes may be acquired. Table 3 presents the volume data by city section and collection type. It is evident that the customer volume varies considerably between city sections, and also between collection types.

TABLE 3. Collection volume in truckload units by city section and collection type.

Collection Type	City Section			
	1	2	3	4
Residential	0.0029	0.0019	0.0022	0.0018
Apartment	0.0028	0.0010	0.0013	0.0012
Residential Type Commercial	0.0106	0.0075	0.0097	0.0112
Daily Commercial	0.0215	0.0101	0.0138	0.0105

The manner in which the data were collected permitted specific time values to be associated with the non-productive time on each route. Non-productive time is identified as that time necessary to compensate for intra-route situations which require excessive travel time with no refuse pickup. This situation occurs on each route due to geographical or zoning constraints. Obviously, the non-productive time is a function of the city section under consideration.

The various collection routes require widely varying time intervals to arrive at the collection locations, and also to return to the landfill. Consequently, a travel time matrix was developed which covers the entire area of consideration. These values were developed by determining the distances to strategic locations from the landfill location, and then factoring in the empirical value developed for the truck travel speed.

The procedure discussed has been programmed on the Univac 1108 system. The output which results from the procedure consists of the appropriate travel time coordinates for each load of refuse to be collected, together with the starting location and the exact streets to be serviced. Furthermore, the output identifies the expected volume for the route, together with a comparison of average route time with actual observed route time. In addition, the type of customers serviced is tabulated for the entire route.

Hence, rather complete statistics are provided by the procedure, thereby providing considerable insight into the solid waste collection

Solid Waste Collection

problem. The physical implementation of the reported results began in late April, 1971. The true implications will not be evident until the system approaches its steady state level.

CONCLUSIONS

This paper presents an efficient and effective procedure for attacking the solid waste collection routing problem. The defined procedure has identified 42 collection routes where previously 48 existed. This solution has resulted in the obvious saving of four routes, which converts into two collection crews and the corresponding collection equipment. This reduction in equipment and manpower requirements is merely a first cut at a tremendously complex, big city problem. Research is currently under way to develop procedures to minimize collection time within a particular route. Since each street must be traveled once to collect the solid waste, the problem is to minimize the time spent in retracing streets while maintaining a feasible solution.

Although the results presented here are for a specific city, applicability is general to any city of any size, regardless of the physical street layout.

REFERENCES

1. Ludwig, H. F., Black R. J., "Report on the Solid Waste Problem," *Journal of the Sanitary Engineering Division, ASCE*, Vol. 94, No. SA2, Proc. Paper 5909, April 1968.
2. Bodner, R. M., Cassell, A., and Andros, P.J., "Optimal Routing of Refuse Collection Vehicles," *Journal of the Sanitary Engineering Division, ASCE*, Vol. 96, No. SA4, Proc. Paper 7451, August 1970.
3. Truitt, M. M., Liebmann, J. C., and Kruse, C. W., "Simulation Model of Urban Refuse Collection," *Journal of the Sanitary Engineering Division, ASCE*, Vol. 95, No. SAZ, Proc. Paper 6508, April 1969.
4. Wyskida, R. M., Wilhelm, M. R., and Mercier, J. L., "Refuse Collection Operations Study," UARI Research Report No. 103, Research Institute, The University of Alabama in Huntsville, February, 1971.
5. Wyskida, R. M., and Gupta, J.N.D., "IE's Improve City's Solid Waste Collection," *Industrial Engineering*, May, 1972.



5.06(26.1)P

THE JOURNAL

OF THE

ALABAMA ACADEMY
OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830

VOLUME 43

LIBRARY
JULY, 1972

NUMBER 3

Officers of the Alabama Academy of Science
1972-1973

	Tenure	Term Begins	Term Expires
PRESIDENT.....Joseph Thomas,	1 year	1972	1973
PRESIDENT-ELECT.....Robert Gudauskas,	1 year	1972	1973
SECRETARY.....Tom Denton,	3 years	1971	1974
TREASURER.....Hoyt Kaylor,	3 years	1972	1975
EDITOR OF JOURNAL.....Elroy Curl,	3 years	1971	1974
COUNSELOR OF THE AAAS.....Roman Skorski,	3 years	1971	1974
PERMANENT COUNSELOR			
OF JUNIOR ACADEMY.....James D. Welker,	3 years	1971	1974
ASSOCIATE COUNSELORS			
OF JUNIOR ACADEMY.....Donald Grigsby,	3 years	1972	1975
Robert P. Bauman,	3 years	1971	1974
COORDINATOR OF			
SCIENCE FAIRS.....G. O. Twellmeyer,	3 years	1971	1974
SECTION I--BIOLOGICAL SCIENCES			
Vice-President.....J. S. Brown			
Vice-Chairman.....Kenneth E. Landers			
SECTION II--CHEMISTRY			
Vice-President.....Virgil M. Benson			
Vice-Chairman.....Samuel P. McManus			
SECTION III--GEOLOGY			
Vice-President.....Denny N. Bearce			
Vice-Chairman.....Ronald Taylor			
SECTION IV--FORESTRY, GEOGRAPHY, AND CONSERVATION			
Vice-President.....John Bourne			
Vice-Chairman.....John Hinton			
SECTION V--PHYSICS AND MATHEMATICS			
Vice-President.....J. Raymond Cooper			
Vice-Chairman.....Oskar M. Essenwanger			
SECTION VI--INDUSTRY AND ECONOMICS			
Vice-President.....Charles Leathers			
Vice-Chairman.....Jack Duncan			
SECTION VII--SCIENCE EDUCATION			
Vice-President.....Ernest Riggsby			
Vice-Chairman.....Myrtle Alexander			
SECTION VIII--SOCIAL SCIENCES			
Vice-President.....Wesley P. Newton			
Vice-Chairman.....Virgil Davis			
SECTION IX--MEDICAL SCIENCES			
Vice-President.....E. M. Weller			
Vice-Chairman.....Allen Hisey			
SECTION X--ENGINEERING			
Vice-President.....John E. Cochran			
Vice-Chairman.....Thomas L. Cost			
SECTION XI--ANTHROPOLOGY			
Vice-President.....E. Earle Smith			
Vice-Chairman.....Helen Mabry			

BOARD OF TRUSTEES

W. J. Barrett, 1970-1973	J. F. Sulzby, Jr., 1971-1974
H. E. Carr, 1970-1973	Sam Barker, 1972-1975
E. V. Smith, 1970-1973	Walter Bouldin, 1972-1975
J. F. Fagen, 1971-1974	Lister Hill, 1972-1975
Howard Milling, 1971-1974	W. B. Jones, 1972-1975
H. M. Philpott, 1971-1974	

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

**AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE**

VOLUME 43

JULY, 1972

NUMBER 3

EDITOR
Elroy A. Curl
Auburn University

ARCHIVIST
Clyde H. Cantrell
Auburn University

E D I T O R I A L B O A R D

Lowell Wilson, Chairman
Auburn University

A. F. Hemphill
Spring Hill College

Ann Everett
Plainview High School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ARTICLES

Help for the Secondary Science Teachers of Alabama— Summer Institutes Elizabeth Manger and Martin C. Manger	155
Designing a Study of the Interaction between Mining and Society in an Urban Environment Henry N. McCarl	159

ABSTRACTS

Biological Sciences	166
Chemistry	176
Geology	180
Forestry, Geography, and Conservation	190
Physics and Mathematics	194
Industry and Economics	198
Science Education	206
Social Sciences	214
Medical Sciences	223
Engineering	224
Anthropology	231
Addendum to Industry and Economics	238

MINUTES OF ANNUAL BUSINESS MEETING	239
--	-----

ERRATUM	246
-------------------	-----

Help for Science Teachers — Summer Institutes

HELP FOR THE SECONDARY SCIENCE TEACHERS OF ALABAMA — SUMMER INSTITUTES

Elizabeth Manger and Martin C. Manger
Department of Chemistry
Alabama A. and M. University, Normal

Help for the secondary teacher is available at Alabama A. & M. University through institutes funded by the National Science Foundation. Returning graduates request further study so that they can teach with a reasonable degree of competency in scientific fields for which they have little or no training. The development of programs such as The Earth Science Curriculum Project, CHEM Study, and others forces the older teacher to return to the college campus. The teacher also needs to expand his field of knowledge as the high school curriculum continues to change and improve.

In adopting the NSF programs, members of the science faculty took the following objectives into consideration: (1) to serve the teacher who is most in need of scientific knowledge and (2) to raise the level of knowledge of entering freshmen by providing additional training for their high school science teachers.

The Summer Institute has been in operation for a period of 9 years and the In-Service Institute has been funded for 8 years. The Summer Institute consists of full time instruction for a 9-week period during which the participant receives 9 semester hour credits. The In-Service Institute is conducted during the fall and spring semesters on Saturdays with the participants receiving 3 hours credit each semester. Our institutes are centered around an Earth Science Program. The Summer Institute offers courses in Earth Science (ESCP methods), Structure of Matter (CHEM Study), Mathematics and Computer Science, while our In-Service program offers only Earth Science and Mathematics.

Each year we have been over subscribed with requests for these programs. The majority of the Summer Institutes applicants are from Alabama, Mississippi, Georgia and Tennessee while all of the applicants live within commuting distance of Huntsville.

The participants are selected on the basis of their immediate need for current scientific knowledge and not upon previous achievement in either their academic or teaching career. Thus, the data presented in this paper do not represent the average science teacher in this central southeast region, but only depict the teachers who realize that they need further training and have made the effort to participate in our programs.

After the operation of these institutes for a period of years and the conduction of many oral interviews, it was felt that more data concerning the effectiveness of the institutes were needed. One of the prime factors considered by the faculty was the immediate value of the institute to the individual participant. Was the teacher able to utilize and introduce those methods and ideas to which he was exposed directly

into his classroom and achieve immediate results?

At a recent meeting of the National Science Foundation Institute Directors, it was pointed out that no documented studies have been made regarding the effectiveness of the institute programs. Therefore, we have conducted a study, in the form of a survey, to evaluate the effectiveness of our institutes.

The participants surveyed were those who have participated in the Summer Institute and In-Service Institute since June 1969. This involves a total of 59 summer participants and 20 in-service participants. From the in-service group there was a 100% return and, from the Summer Institute Program, a 66% return.

The average participant in the program has been characterized as having 12.2 years of teaching experience and 8.5 years of teaching either math or science courses. The majority of the teachers come from rural areas. The average number of teachers in each school was 27.4 with approximately 2 science teachers per school. General science and biology are offered at the majority of the schools where those surveyed teach, while less than 2% of these schools offer advanced science courses. Thirty-four percent of the teachers had undergraduate science majors and 43% chose science as a minor. Many of the science majors also minored in a science, hence only 56% of all participants have had either a science major or minor. Forty-four percent had neither a science major nor minor even though they are now teaching science courses. One-half of the respondents reported that they were teaching because of their academic training and 39% indicated that they were teaching these subjects only because they were requested to do so by their superiors; 11% of the respondents did not answer this question. In rating their knowledge of scientific matter, 54% considered their knowledge to be up to date and 45% of the teachers believed their knowledge to be inadequate. Two-thirds of the teachers reported that they had the use of laboratory facilities and one-third reported that they did not. Seventy-five percent of the teachers indicated that they were able to make maximum use of most of their equipment, but 41% reported that they had some equipment that they did not know how to use. Twenty-three percent of the participants reported using the teacher demonstration method for their laboratory work, and 23% used individual laboratory experiments, while the remainder reported using a combination of demonstration and individual laboratory experiments.

In view of the above data, it is interesting to note that the majority of the teachers felt that their knowledge of scientific materials and developments was up to date even though science was not a major part of their undergraduate program. Another point worth noting is that almost one-half of the teachers still were not able to use the equipment available to them even though they had attended the institute. Finally, the use of the demonstration method was attributed to the lack of laboratory facilities.

Because of the inadequate scientific training of many of the secondary teachers, the Summer Institute was initiated offering courses at

Help for Science Teachers — Summer Institutes

the beginning level in earth science, structure of matter and mathematics. After 9 years we realize this lack of training among teachers is decreasing as evidenced by continued improvement in the achievement level of our entering freshmen and by content of the application forms. A very high percentage of our present applicants have had previous institute experience and some graduate training. However, their graduate training is principally in education and related courses and not in the basic sciences that are needed to insure competency in the classroom. We receive many requests for information, experiments, and supplies from these teachers because they do not know where to obtain resource materials. With these facts in mind we have modified our institute by adding computer science to the curriculum and emphasizing NSF-sponsored programs such as the CHEM Study and ESCP programs. Correlation of theoretical aspects with experimental procedure allows the teacher to experience some of the problems encountered by the students and, at the same time, provide him with basic knowledge and experimental procedures that can be used in the classroom.

One specific experiment which has received favorable comment from past participants is in the Earth Science curriculum relating to the identification of hand held rock samples. It illustrates and emphasizes the basic scientific concept of observation and subsequent classification of data leading to the identification of a set of rocks. It should be borne in mind that these individuals have almost no background in geology and have either not encountered or never mastered the scientific method. This experiment also applies concepts that are simultaneously presented in the course, Structure of Matter. Thus, there is some interrelationship of material presented in the different courses offered at the institute. The following is a brief outline of the rock identification experiment.

I. Objective

II. Materials

Ward's Syracuse University Rock Collection
Magnifier
Testing Needle

III. Procedure

- A. The students are simply handed the box of rocks and asked to list all properties that can be observed concerning the specimen.
- B. During this period, properties such as color, density, crystal structure, solubility, hardness and other topics are brought out and discussed in detail and related to methods of classification.
- C. Density determinations are made on selected specimens and the data utilized in the ultimate identification of the sample. The data are used in the computer science section as source material for writing simple computer programs to demonstrate computer techniques and capabilities.
- D. After the classification procedure has been completed

- and each student has grouped his rock collection, actual identification is then made by consulting the reference books placed in the laboratory for their use.
- E. Each student is then provided with a sheet listing the identifying characteristics of each sample in his kit and set of labels including the name and source of his specimen.

In this manner each participant ends up with a set of correctly identified rocks which can be taken directly back to the classroom. Subsequent work involves field trips to collect samples and observe formations, etc. These experiments remain as open ended as possible to encourage further work or study.

As a direct result of this experiment these teachers indicate that they now have the confidence to identify rock samples presented by their students even though they do possess only a limited background in the area of earth science.

Thirty-six percent of the participants were able to initiate the ESCP program into their schools upon their return. The major reasons given for not initiating the program are: (1) lack of familiarity with the program, (2) lack of funds, (3) lack of equipment, and (4) program not suited to their particular school curriculum. One individual stated that his students were not mentally capable of undertaking the program..

The following comments, summarized from the survey, indicate some of the benefits and ideas gained by the participants at NSF Institutes:

- exchanging ideas
- possible student projects
- awareness of library and audio-visual materials
- methods of evaluation
- updating of scientific knowledge
- better classroom preparations
- added sense of security
- familiarity with scientific equipment
- better student-pupil relationship
- plans to acquire needed equipment
- introducing experimental investigation rather than relying exclusively on lecture techniques

In conclusion, we would like to quote one of our participants on the value of National Science Foundation Institutes: "My first NSF Institute at Washington University, St. Louis was extremely beneficial. In undergraduate school my instructors were extremely superficial in their teaching. At Washington University and later at Alabama A. & M. University, I gained some of the much needed knowledge and skills that are necessary to do quality teaching. For people that are in the teaching profession (science) the NSF is a dream come true. I recognize the importance of quality in all disciplines, and the NSF has helped me do the kind of job that I feel I was expected to do, or rather, wanted to do."

Interaction between Mining and Society

DESIGNING A STUDY OF THE INTERACTION BETWEEN MINING AND SOCIETY IN AN URBAN ENVIRONMENT

Henry N. McCarl
Department of Economics
University of Alabama, Birmingham

The traditional mining study or economic impact analysis of mineral extraction has, historically, dealt with the direct economic implications (employment, value-added, resource utilization, payrolls, etc.) of such activity. With the increasing public attention on pollution and other external effects of mining development, it becomes imperative to deal not only with the direct economic impact of mining activity, but also with the related social costs and benefits in order to obtain a more complete evaluation of the place of mineral extraction in our regional and national economies.

External or social costs are those expenses or values associated with the production of goods and services that are borne by society rather than by the industry, household, or governmental agency actually creating them. These costs are external to the normal business considerations.

Social costs associated with mining include emissions of gaseous, particulate, and other materials into the atmosphere. Additionally, disposal of industrial chemicals, silt and dust, mine drainage sewage, and other wastes into streams, rivers, lakes, and the ocean create environmental diseconomies. Finally, the accumulation of spoil banks, removal of forest and ground cover, creation of safety hazards such as deep pits and quarries, unstable slopes, presence of explosives, increased truck traffic, noise, vibration, congestion, and blasting hazards all comprise costs to society.

External or social benefits are those economic improvements or contributions made to society by the production of goods or services that do not provide direct economic benefits to the activity or industry that creates them. In mining, such benefits include the possible creation of parks and increased land values after mining is discontinued, possible provisions for new or improved roads and railroads originally utilized by the mining activity, and potential population growth associated with industrial development making possible certain economies of scale in the provision of public goods and services. Social benefits rarely, if ever, offset the social costs of mining activity. The external costs must be internalized or the direct economic benefits of industrial growth must offset these costs, or some combination of internalization and offset compensation must be achieved, in order to reach a truly optimal economic solution.

The historical resolution has been to maximize industrial growth and enjoy its economic benefits as the environment absorbed the external costs and diffused their impact to a tolerable level. As population grows and industry expands, the costs become greater, the environment less able to absorb costs, and the people (society) more aware that the

costs are real and becoming critical. Additional laundry and dry cleaning, new paint for the home, the external appearance of the family car, and increased health problems are being paid for by the individual segments of society, and these individuals are better informed as to how these social costs arise.

The question arises: How do we judge the real economic worth of new industrial growth from the viewpoint of society as a whole? The problem becomes one of designing an evaluation procedure that regional planners can use to determine the net economic benefit of locating a new mine, quarry, or any industrial activity within their planning region.

Techniques for the direct measurement of mineral values of existing deposits and direct economic benefits of new industry have been available and utilized for some time, but these methods fail to measure the social costs and benefits of such potential mining ventures.

The conflicts and problems between mining and society are receiving more and more attention at the national and state levels, but they are perhaps most acute in the urban areas of our country. Sand and gravel, crushed and dimension stone, salt, clays, oil and gas, and even certain metals, are currently (and potentially) extracted within areas of high population density, normally considered to be urban or metropolitan economic regions. Most of these regions have planning and zoning authorities that have not dealt with mining as an important economic activity except as problems have arisen, and then only on a case-by-case basis.

In rare instances, some emphasis has been focused on long-range planning for mineral extraction within economic regions¹, but each approach has been independent, with limited effort given to the general problem of developing and applying a unified theoretical framework. Mineral extraction will continue to be an important, or at least a potentially necessary, economic activity within the urban environment. Many mineral deposits are located within urban areas (8, pp. 45-46). We can, of course, utilize lower-value deposits at greater distances from the major market centers, but this entails a cost. Before we can ascertain the desirability of incurring that cost, we must be able to evaluate the overall economic consequences of such mining activity. To do so, we must have an analytical framework that permits us to deal with the traditional economic benefits, as well as with the now-popular ecological costs, of such industrial development. The purpose of this paper is to review and evaluate one method of measuring the desirability of certain mining ventures in an urban region.

The general framework for analysis of the desirability of mining or other industrial expansion in an urban area has been outlined by

¹These studies have been sponsored by the U. S. Bureau of Mines on mineral extraction in Denver, Colorado; Baltimore, Maryland; Atlanta, Georgia; and Albany, New York.

Interaction between Mining and Society

Cumberland (3), Ayres and Kneese (1), and Isard (4). Since Dr. Isard's book has not yet been released, this discussion will focus on the contributions of Cumberland and Ayres and Kneese. Both models are comprehensive input-output approaches with built-in considerations of social benefits and costs, often referred to in the economic literature as externalities.

Input-output analysis is based on the collection of data on money and material flows between various sectors of a regional or national economy. As it relates to a regional impact of mining activity, at least one sector would be extractive industries. A table or matrix is designed with all economic activity broken into production groups (sectors), and these same groups are usually listed as purchasing or receiving groups. There is a distinction made between the "intermediate use" sectors that purchase goods and services to be used in the production of final goods and services and the "final use" sectors that purchase or consume the finished capital goods or consumer products and services.

The major "intermediate" sectors would be agriculture, mining, manufacturing, industrial services, trade, and various other industrial groups. The major "final" or "value added" sectors would be households, government, and business investment or savings. However, the number of sectors can be greatly expanded to give more detail if desired. All flows from one sector to the others are summarized in the table. From these data a series of simultaneous equations can be designed to represent general interindustry flows and the economic interdependence of the various sectors. The advent of modern computers has enabled a relatively detailed breakdown of the major categories as well as rapid solution for the resulting set of equations. From this we obtain a set of coefficients that describe the general interdependence of sectors. By then inserting changes such as the impact of a new mining venture into the appropriate sector, and again employing the computer to execute matrix operations based on the interaction coefficients, the planner can determine the traditional economic impact of such industrial development. The addition of environmental impact, or consideration of externalities to this analysis are the significant contributions of Cumberland (3) and Ayres and Kneese (1).

The importance of the input-output approach to the evaluation of the economic feasibility of mining or other industrial activity in any particular geographic region is that the analysis does not neglect to show the secondary impact, and other residuals (tertiary, etc.), of such development. In fact the great benefit of input-output analysis over the study of a single industry and its primary impact is the dynamic aspect, or interaction between industrial sectors and the gross or total impact of changes in all sectors brought about through changes in a single sector. Social costs and possible social benefits cannot be fully assessed by the primary impact of an additional quarry, mine, or other industrial facility, because all other effected sectors create residual contributions. The complexity introduced through this dynamic interaction creates the greatest problem in employing input-output analysis to evaluate environmental factors.

TABLE 1. Regional interindustry model including environmental factors [from John H. Cumberland (3)].

Producing Sector \ Purchasing Sector			Intermediate Sale					Final Demand				Total Purchases by Regional Economy	Total Exports	Gross Regional Product Total Purchases From Regional Economy	Environmental Balance	
			Agriculture 1	Manufacturing 2	Service J	Trade •	Other N	Total Intermediate W	Household C	Capital Formation I	Government G					Total Final Demand Y
Intermediate Purchases	Agriculture	1	X_{11}	\cdot	X_{1j}	\cdot	X_{1n}	W	C_1	I_1	G_1	Y_1	D_1	E_1	X_1	B_1
	Manufacturing	2	\cdot													
	Services	I	X_{i1}		X_{ij}	\cdot	X_{in}	W_i	C_i	I_i	G_i	Y_i	D_i	E_i	X_i	B_i
	Trade	•	\cdot													
	Other	N	X_{n1}		X_{nj}		X_{nn}	W_n	C_n	I_n	G_n	Y_n	D_n	E_n	X_n	B_n
	Total Intermediate	U	U_1	\cdot	U_j	\cdot	U_n	U_w	C_u	I_u	G_u	Y_u	D_u	E_u	X_u	B_u
Value Added	Wages and Salaries	L	L_1	L_j			L_n	L_w	C_L	I_L	G_L	Y_L	D_L	E_L	L	B_L
	Other Household Income	R	R_1	R_j			R_n	R_w	C_r	I_r	G_r	Y_r	D_r	E_r	R	B_r
	Regional Personal Income	H	H_1	H_j			H_n	H_w	C_h	I_h	G_h	Y_h	D_h	E_h	H	B_h
	Business Savings	F	F_1	F_j			F_n	F_w	C_f	I_f	G_f	Y_f	D_f	E_f	F	B_f
	Government Receipts	T	T_1	T_j			T_n	T_w	C_t	I_t	G_t	Y_t	D_t	E_t	T	B_t
	Value Added	V	V_1	V_j			V_n	V_w	C_v	I_v	G_v	Y_v	D_v	E_v	V	B_v
	Total Sales by Regional Economy	S	S_1	S_j			S_n	S_w	C_s	I_s	G_s	Y_s	D_s	E	X	B
	Total Imports	M	M_1	M_j			M_n	M_w	C_m	I_m	G_m	Y_m	M			
	Total Sales to Regional Economy	Z	Z_1	Z_j			Z_n	Z_w	C	I	G	Y	D			
	Environmental Benefits (+)Q Environmental Costs (-)C Environmental Balance	A	A_i	A_j			A_n	A_w	A_c	A_i	A_g	A_y	A			

Interaction between Mining and Society

Cumberland's model (3, pp. 86-89), shown in Table 1, employs the addition of extra rows and columns to the normal input-output matrix to reflect the environmental aspects. He employs a row (Environmental Benefits) to reflect the private or locational benefit to the industrial sector, and an additional row (Environmental Costs) to reflect the net social costs such as fish kills, aesthetic deterioration, and air pollution (3, p. 88). The third row (Environmental Balance) assesses the net effect of "benefits" and "costs" to the various sectors (Table 1). A column (Environmental Balance) details the necessary compensation or cost of correction for the externalities. Thus if locational benefits are greater than net social costs or locational benefits are greater than correction costs, the community benefits through the location of the new industrial development. The difficulty of valuing the externalities and locational advantages is indicated by Cumberland in his concluding remarks (3, p. 94):

"If the quality of economic development is to be accepted as an important objective, much more research is needed on the nature of externalities and upon the costs and benefits of alternative development patterns."

Ayres and Kneese (1) present a somewhat more rigorous approach to the problem of externalities by introducing artificial prices into their model. They utilize positive artificial or shadow prices for common-property resources such as atmosphere, streams, lakes, oceans, landscape, etc. in much the same way as "dummy" variables are introduced into linear programming equations. Negative artificial prices are introduced for social costs or environmental disservices such as pollution, safety hazards, etc. These artificial prices are then introduced into the simultaneous equations of the input-output format as important modifying conditions to the interindustry effects. The pragmatic difficulty in utilizing such an approach is in arriving at an appropriate real value for the common property resources as well as the residuals or environmental effects. Ayres and Kneese refer to this problem in their concluding remarks (1, p. 295):

"While we feel that (the model) represents reality with greater fidelity than the usual view, it also implies a central planning problem of impossible difficulty, both from the standpoint of data collection and computation."

Ayres and Kneese (1, p. 296) conclude by indicating that methods of evaluating external costs and in estimating control costs will continue to be developed and that some consideration of such externalities is vitally important in future planning for industrial development. They also indicate the desirability of considering a general equilibrium approach involving all interindustry flows rather than isolating one sector such as mining and attempting to use a partial equilibrium treatment.

Thus, although somewhat expensive in terms of data collection and

analysis, the regional input-output approach seems to have real value in planning for mining or any other industrial development with certain modifications to encompass the social costs and benefits. The major problem in utilizing this analytical technique is the estimation or assignment of dollar values to the various social costs and benefits.

Some investigators, e.g., Wolozin (9), have supported the idea that complete estimates are not necessary. This viewpoint holds that improved decisions on the desirability of industrial expansion can be based on partial or incomplete economic estimates of external costs. Wolozin (9, p. 33) suggested that the construction and assemblage of national estimates could be utilized as guidelines at the regional level. He further suggested (9, pp. 33-35) that an understanding of the functional relationships between pollution levels and abatement outlays would be useful in determining optimal levels of correction expenditures with the use of marginal analysis. The construction of such functional relationships will require considerable outlays of research funds at national and state or regional levels, and the time necessary to arrive at such an optimal solution seems to disregard the urgency of current needs.

Ruff (7, pp. 2-3) approached the problem of evaluating externalities inferences from other prices, conducting public opinion polls, and correction costs. Brooks (2, pp. 36-37) cited earlier work by Kneese, and supports the proposition that the cost of such externalities as destruction of scenic views be valued as the cost of correction or restoration to some acceptable standard. Both Ruff and Brooks seem to support a pragmatic approach that sets some acceptable standards and applies the cost of meeting the standards as the minimal external costs.

It is apparent that further work is needed in the estimation and evaluation of externalities. However, the need for answers is likely to arrive before satisfactory evaluation methods are designed. It is therefore suggested that current planning efforts utilize available regional and national input-output techniques when possible to provide a better basis for judgement than is currently employed. Although there are obvious difficulties in the implementation of external cost analysis as indicated above, the basic information available through a comprehensive input-output approach, even without external considerations, still places planning authorities in a more knowledgeable position on the direct economic impact of any proposed industrial expansion. And until estimations of external costs and benefits are available to modify the input-output methods as described above, it is the suggestion of this author that the appropriate governmental or regulatory agencies proceed to set out very strict environmental quality guidelines, considerably more stringent than the levels regarded as minimally hazardous. However, such agencies should be willing to modify these standards in light of the private economic costs to the affected industries, the enforcement costs to the government, and the traditional economic benefits to the community as reflected in the available input-output results.

Most importantly, it is vital to the future of our society that we move in the direction of control, or at least consideration of social

Interaction between Mining and Society

costs, in judging the economic desirability of a new mining or other industrial venture. These problems are most critical in the heavily concentrated industrial centers, and thus their impact is most significant and costly in the urban area. We must move in the proper direction in planning our future. We cannot permit our cities to die waiting for a "best" solution.

LITERATURE CITED

1. Ayres, R. U., and A. V. Kneese. "Production, Consumption, and Externalities," *American Economic Review*, Vol. 59, No. 3, June, 1969, pp. 282-297.
2. Brooks, D. B. "Strip Mine Reclamation and Economic Analysis," *Natural Resources Journal*, Vol. 6, No. 1, January, 1966, pp. 13-44.
3. Cumberland, J. H. "A Regional Interindustry Model for Analysis of Development Objectives," *Papers of the Regional Science Association*, Vol. 17, 1966, pp. 65-94.
4. Isard, W. *Ecological Economic Analysis for Regional Development*, New York: The Free Press, 1971, 450 pp.
5. Krutilla, J. V. "Conservation Reconsidered," *American Economic Review*, Vol. 57, No. 4, September, 1967, pp. 777-786.
6. Mishan, E. J. *The Costs of Economic Growth*, London: Staple Press, 1967, 190 pp.
7. Ruff, L. E. "Pollution Control and the Price System," *Alabama Business*, Vol. 40, No. 5, January 15, 1970, pp. 1-3.
8. Stephenson, R. C., Chairman. *The Interaction of Urbanization and the Mineral Industries*, Proceedings of the Annual Meeting of the Natural Resources Institute of the Ohio State University, Columbus, Ohio: Ohio University, May 18, 1965, 90 pp.
9. Wolozin, H. "The Economics of Air Pollution: Central Problems," *Air Pollution Control*, Dobbs Ferry, New York: Oceana Publications, Inc., 1969, pp. 31-42.

ABSTRACTS

Papers presented at the 49th Annual Meeting
Jacksonville State University
Jacksonville, Alabama
April 13-15, 1972

BIOLOGICAL SCIENCES

AN ACID AND ALKALINE PHOSPHATASE DEFICIENCY OF THE DAUGHTERLESS MUTATION IN *DROSOPHILA MELANOGASTER*

Jake H. Barnes and J. E. Watson
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

Bell, in 1954, reported a sex limited maternal effect termed "daughterless" (da), which is characterized by producing no female progeny when the dam of a cross possesses a homozygous recessive mutant genotype. Previous reports indicated the time of lethal action to occur in the egg stage. Such mutations are being investigated by electrophoresis which enables the biologist to study the gene-enzyme systems at the molecular level.

The improvement in recent years of electrophoresis techniques for enzyme separation has led to the finding of numerous enzyme polymorphisms in a large variety of organisms. The combination of starch gel electrophoresis with different enzyme staining methods has greatly facilitated the possibilities to study different molecular forms of enzymes. The altered electrophoretic mobility reflects a change in the net charge of the protein molecule which occurs when the amino acid carries a charge different from that of the one it replaces. The substitution presumably reflects a base-pair substitution in the DNA chain and thus represents a mutation in a structural gene. Comparisons made can indicate the altered enzyme activity produced by a mutant individual.

Homogenates of 24-hour adult "daughterless" and Oregon-R females were examined by means of starch gel electrophoresis. The enzyme systems investigated were: malic dehydrogenase (MDH), aldehyde oxidase (AOX), acid phosphatase (ACP), alkaline phosphatase (APH), esterase (Est), and leucine aminopeptidase (LAP). Comparisons made between "da" and Org-R flies indicated a difference in two of the six enzyme systems investigated.

For APH, where no enzyme activity has been previously reported, in *D. melanogaster*, three lightly stained bands were observed in Org-R females. The bands were designated as A₁, A₂, and A₃. In contrast,

Abstracts

only the A₁ and A₃ bands were present in "da" individuals. ACPH activity indicated the presence of an A₁, A₂, and A₃ band for Org-R females, while only the A₁ and A₂ bands were observed in the "da" females.

Further studies of unfertilized eggs of Org-R females indicated the presence of an E₁ and E₂ band. In both gels stained for APH and ACPH activity, the E₂ band was absent for both enzyme systems in the eggs of virgin "da" females.

Such results suggest an altered activity in the ability of the phosphatase enzyme to bring about the hydrolysis of esters of phosphoric acid, or the ability to catalyze transphosphorylation in "da" individual.

CULTIVATED FLOWERING SHRUBS OF NORTHEAST ALABAMA

Thomas Cochis and Kenneth E. Landers
Biology Department
Jacksonville State University
Jacksonville, Alabama

Flowering shrubs are used extensively in the landscaping of homes in Northeast Alabama. Twenty of the most popular species of cultivated flowering shrubs are described. These are: *Abelia grandiflora*, *Hibiscus syriacus*, *Chaenomeles japonica*, *Calycanthus floridus*, *Forsythia suspensa*, *Camellia sasanqua*, *Camellia japonica*, *Hydrangea arborescens*, *Hydrangea macrophylla*, *Hydrangea quercifolia*, *Jasminum floridum*, *Kerria japonica*, *Lagerstroemia indica*, *Magnolia soulangeana*, *Rhododendron obtusum*, *Rhododendron* spp., *Spiraea prunifolia*, *Robinia hispida*, *Viburnum* spp., *Weigela japonica*.

DESCRIPTION OF THREE NEW GENERA AND THREE NEW SPECIES OF TOMASPIDINI (INSECTA: HOMOPTERA: CERCOPIDAE)

Danice H. Costes
Department of Biological Science
Troy State University
Troy, Alabama

Three new genera and three new species of Tomaspidini from Central and South America are described. The Major morphological characters used in these descriptions are the male genitalia which are illustrated.

THE FRESHWATER FISHES OF THE BANKHEAD NATIONAL FOREST IN ALABAMA

Donald D. Dycus and William M. Howell
Samford University, Birmingham, Alabama

A survey of the streams in the William B. Bankhead National Forest, which contains tributaries to both the Tennessee River and the

Sipsey Fork of the Black Warrior River, was conducted to determine the content and distribution of the fish fauna. The location and physiographic characteristics of the area were presented.

The study was based on specimens taken in 86 collections from 75 different stations and revealed the presence of 78 species of fishes and one hybrid. Range extension for two undescribed fishes, *Etheostoma* (*Ulocentra*) species and *Percina* (*Alvordius*) species, and representatives of six additional fishes not collected elsewhere in the upper Warrior River were discussed along with 13 species which are rarely collected in the upper Warrior River. The presence of relict populations within the Bankhead National Forest and the deleterious effects of certain activities of the U.S. Forest Service to these populations were presented.

HABITAT AND DISTRIBUTION OF BARTRAM'S *OENOTHERA GRANDIFLORA* IN BALDWIN COUNTY, ALABAMA

Verda Horne
Fairhope, Alabama

Oenothera grandiflora was observed by William Bartram in the Alabama River delta, now part of Baldwin County, when he travelled in the area in 1775-76. Subsequent studies have failed to identify any significant indigenous sites for this species.

The site was visited in 1912 by Hugo DeVries, the Dutch botanist who had formulated his theory of mutations after experiments with a related species, *Oenothera lamarckiana*. Despite scientific interest in the unusual plant described by Bartram as "perhaps the most pompous and brilliant herbaceous plant known to exist" the species is in a precarious site as development threatens its very limited habitat.

THE FRESHWATER MOLLUSCA OF WESTERN LEE COUNTY, ALABAMA

John C. Hurd and Hugh B. Cunningham
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

From April, 1970 through June, 1971 a survey was conducted of the molluscan faunae of the Chewacla and Saugahatchee creek drainages in western Lee County, Alabama. Representatives of 24 species were encountered, including seven snails and 17 bivalves.

Four of the snail species were of the genus *Goniobasis*; others were the planorbid *Helisoma trivolvis*, the viviparid *Campelema decisum* and the pulmonate *Physa pomilia*. The bivalves encountered included the pea clam *Sphaerium fabale* and 16 naiads (Unionidae). No corbicula were found. All three subfamilies of naiads were found: Anodontinae--*Anodonta imbecillis* and *Strophitus undulatus*; Lampsilinae--*Lampsilis anodontoides*, *L. claibornensis*, *L. clarkiana*, *L. excavata*, *Potamilus purpurata*, *Leptodea fragilis* and *Toxolasma paula*; Unioninae--*Tritogonia verrucosa*, *Fusconaia rubida*, *Quadrula asperata*, *Elliptio arctatus* and *E. buckleyi*.

Lee County is situated on the fall-line with Chewacla Creek

Abstracts

draining an area which is predominantly upper coastal plain, while Saugahatchee Creek flows its entire length within the peidmont province.

Various industries create an unnatural situation in these drainages. Auburn Stone Company operates a quarry near Chewacla Creek and allows a silt-laden effluent to enter the creek. West Point-Pepperell allows an effluent from their polishing pond to enter Saugahatchee Creek. This effluent contains a solution and suspension of fats, oils, carbohydrates and bio- and nonbiodegradable dyes. The effects of these influents upon the freshwater molluscans were studied.

SPRING FLOWERING HERBACEOUS DICOTS OF NORTHEAST ALABAMA

Kenneth E. Landers, Thomas Cochis, and Rodney Whited
Biology Department
Jacksonville State University
Jacksonville, Alabama

The spring flora of the roadsides, lawns, fields, and woodlands of Northeast Alabama is rich and varied. Many flowering herbs of the Great Smoky Mountains also grow along the highland rim uplands, shale and sandstone hills, and in the limestone valleys of the area. Some species have not been collected or studied extensively and their distribution in Alabama is omitted from a number of field guides, keys, and manuals.

The bluets (*Houstonia caerulea* L. and *H. pusilla* Schoepf), spring-beauty (*Claytonia virginica* L.), and wild pansy (*Viola rafinesquii* Greene) are common early spring flowers of lawns and open areas. Round-lobed liverleaf (*Hepatica americana* (DC.) Ker), bloodroot (*Sanguinaria canadensis* L.), saxifrage (*Saxifraga virginensis* Michaux), windflower (*Thalictrum thalictroides* (L.) Boivin), toothworts (*Cardamine* spp.), and Wood's vetch (*Vicia caroliniana* Walter) are among the first spring flowers of the woodlands in early March. Blue phlox (*Phlox divaricata* L.), pennywort (*Obolaria virginica* L.), blue star (*Amsonia tabernaemontana* Walter), shooting star (*Dodecatheon meadia* L.), violet wood sorrel (*Oxalis violacea* L.), and wild geranium (*Geranium maculatum* L.) begin flowering during late March or early April. Other herbs flowering in March and April are may-apple (*Podophyllum peltatum* L.), fire pink (*Silene virginica* L.), columbine (*Aquilegia canadensis* L.), dwarf larkspur (*Delphinium tricorne* Michaux), stonecrop (*Sedum ternatum* Michaux), and foamflower (*Tiarella cordifolia* L.). Small's groundsel (*Senecio smallii* Britton) is in flower in woodlands by April and often one of the most common flowers of the roadsides and fields during May. Other conspicuous herbs which flower during April, May, or early June are sun-drops (*Oenothera fruticosa* L.), goat's rue (*Tephrosia virginiana* (L.) Persoon), Indian pink (*Spigelia marilandica* L.), Jacob's ladder (*Polemonium reptans* L.), wood-mint (*Salvia urticifolia* L.), and scorpion-weed (*Phacelia bipinnatifida* Michaux), and wood betony (*Pedicularis canadensis* L.). Some additional interesting, uncommon, or rare flowering herbs of the area which are usually not listed in taxonomic works as occurring in Alabama are moth mullein (*Verbascum blattaria* L.), Alleghany spurge (*Pachysandra procumbens* Michaux), hoary puccoon (*Lithospermum canescens* (Michaux) Lehmann), Dutchman's breeches (*Dicentra*

cucullaria (L.) Bernh.), elf-orpine (*Sedum smallii* (Britton) Ahles), and sharp-lobed liverleaf (*Hepatica acutiloba* DC.).

DETERMINATION OF HOW BHT CAUSES DECREASE IN OVIPOSITION
IN *DROSOPHILA MELANOGASTER*

Robert Oliver and J. E. Watson
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

Butylated hydroxy toluene (BHT), an antioxidant used as a preservative in cereals, when added to the medium of *Drosophila melanogaster* causes a modification of oviposition. This specific modification is generally a retention of eggs in the uterus and a subsequent reduction in the development of succeeding oocytes. Determination of how flies detect this irritant has been undertaken.

One observation noted during the course of the experiment was facilitation. It was seen that an increase in the number of females introduced to the same medium plate caused a higher relative increase in the number of eggs oviposited. However, an extremely high number of females caused a relative decrease in fecundity. Also noted was the tendency for egg aggregation. Higher numbers of females resulted in the majority of eggs being laid in a few choice ovipository sites. These effects have also been noted in other studies of behavioral traits.

Insects in general perceive all stimuli through sensilla, much like vertebrates. These sensilla are innervated typical or modified setae. In *Drosophila* the arrangement of the larger bristles or chaetae, and the form of these bristles, are dependent on an invisible "prepattern" of determination established at an early stage of development and controlled genetically.

Chemoreception, such as taste and smell, is probably due to stimulation of sensory endings which normally respond to other stimuli. The legs of termites, cerci of crickets, and basal segments of antennae in other insects are sensitive to irritants. It is known that the extreme tips of setae in *Musca*, *Phormia* (the black blow fly), *Sarcophaga*, and *Drosophila* are also known to extend the proboscis if the tarsi come in contact with sweetened water. It has been shown repeatedly that the sense of smell is located chiefly in the antennae. The *Drosophila* mutant "Antennaless" does not respond to olfactory stimuli, although its other reactions are normal.

If, therefore, these structures should receive stimuli in a normal pattern, modified structures should receive stimuli in a modified manner or not receive stimuli at all. Therefore, bristle, antenna, proboscideal, and tarsal mutations (as well as others) are being used to determine which specific structure (or structures) perceive or do not respond to the irritant BHT.

As stated, the modified oviposition behavior is caused by the presence of BHT and is characterized by the retention of eggs (stage 14 oocytes) in the uterus. Thus, if the premise of a modified structure either receiving a stimulus in a modified manner or not at all is true, then the strain of *Drosophila melanogaster* mutant for the structure that receives the irritating stimulus of BHT should oviposit in a normal

Abstracts

pattern and number.

Results obtained to date are limited to facilitation and aggregation phenomena. In tests with Spineless Aristapedia, Aristaless, Black Body, Straw Body, Yellow Body, Forked Bristle, Split Bristles, Thread Antennae, Canton S, Oregon-R and W 101 — introduced to plates at a ratio of one female to one male — approximately three eggs per plate were noted. These same mutant strains plated at a ratio of four females to four males had 30-50 eggs per plate. In each case the tendency to aggregation was noted.

A MATHEMATICAL ANALYSIS OF HUMAN DERMATOGLYPHS

Mary L. Padgett and J. E. Watson
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

Analysis of the ridge count of the ring finger of the right hand (digit RIV) has been undertaken. Ridge count is defined as the number of ridges crossing a straight line drawn from the core or center of the pattern to its triradius. A triradius is an area where three fields of parallel ridges meet. Some patterns have two or more triradii so several ridge counts may be made. The largest count is used. Total ridge count (TRC) is the sum of the largest counts of all ten digits.

Previous analyses of ridge count conducted by Holt, Penrose and others have focused on total ridge count and comparison between digits (Holt, S. B., 1968, The Genetics of Dermal Ridges, Charles C. Thomas, Springfield, Ill.). Digit RIV was indicated by Holt as the one having the highest parent-child ridge-count correlation. Thus a detailed examination of this digit has been undertaken. The procedures of Holt have been extended to include large families of several generations in order to test any uncovered inheritance modes.

The regression of offspring on midparent and various correlations between relatives were calculated. The specific determinations and their theoretical values, assuming totally additive inheritance without environmental effects, are: (1) In regression of offspring on midparent, $B = 1.0$. (2) For correlation of sibs within sibships, $r_I = 0.5$. r_I is found from the usual analysis of variance where:

$$r_I = \frac{MSW - MSB}{MSB + (k-1)MSW}$$

MSW = mean square within sibships
MSB = mean square between sibships
k = number of sibs per sibship
corrected for unequal numbers within sibship (Cochran, W. G., 1939, J. Am. Stat. Assoc., 34:492)

and

$$k = \frac{N^2 - \sum n_i^2}{N(c - 1)}$$

N = total number of sibs
 n_i = number of sibs in sibship
c = number of sibships.

(3) For cousin-cousin correlation $r_I = 0.25$. The average value for each sibship is taken and variance is partitioned into between-family (MSB) and cousin-within-family (MSW) components. (4) For parent-parent correlation, $r = 0.0$ in random mating.

Results obtained compare favorably with Holt's values for total ridge count and the sum of RIV and LIV ridge counts. Holt's regression of offspring on parent for TRC was 0.9; whereas, our value for RIV was 0.99. Both regressions were linear but our RIV data showed more variation from regression line than the TRC data. Correlation between sibs was 0.50 ± 0.04 for TRC, 0.47 for RIV and LIV combined, and our value for RIV was 0.498. Correlation between cousins for our RIV data was 0.24. Correlation between parents was not significantly different from zero in any case, so matings were random. The correlations computed for RIV are slightly higher than they would have been if small families had been used.

These results indicate that the ridge count of RIV in offspring is almost totally accounted for by the values of the parents. Correlations correspond remarkably well to those expected when additive gene action is present but dominance, epistasis and environmental effects are very low.

BASELINE STUDIES ON THE EFFECTS OF A LOW MAGNETIC
FIELD (50 GAMMAS) ON THE EMBRYONIC DEVELOPMENT
OF *FUNDULUS HETEROCLITUS*

John R. Russell, III
Biology Department
Athens College, Athens, Alabama

Experiments were conducted to evaluate the effects of a low magnetic field on selected developmental processes of *Fundulus heteroclitus*. Experiments were designed to investigate the effects of a low magnetic field on the developmental processes of mummichog embryos as follows: (1) Embryos were exposed at various developmental stages to a normal magnetic field (approximately 50,000 gammas) and a low magnetic field (50 gammas). (2) Embryos were exposed to varying salinity concentrations (90.18‰ - 0‰) in order to determine the effect of active transport and passive diffusion on embryonic development. (3) Embryos were subjected to varying exposure times, ranging from 22-344 hr, to determine the influence of increased exposure time under a low magnetic field to the development sequence of the embryo.

Observations showed that the majority of anomalies occurred between the fertilized egg and early blastula stages. The following anomalies were observed for embryos exposed to the low magnetic field (in decreasing order of occurrence): eye deformities (cycloptic, right eye missing, reduced eyes, eyes combining, and complete degeneration of eyes), reduced yolk (often resulting in death at mid-stage of development), vertebral column flexion, pericardium and heart malformations, and stubbed tail.

Hatching time was shorter in the majority of developmental stages exposed to the low magnetic field. However, the survival rate was greatly decreased, which could be attributed to the rapid utilization

Abstracts

of yolk material. This might indicate a more rapid metabolism of embryos exposed to a low magnetic field. Embryos that reached the hatching stage, but did not hatch, possibly could have used up all of the yolk material which normally persists for several days after hatching. The embryos lost viability, due partially to their inability to secrete the enzymes necessary to digest the chorion, but also due to the lack of muscle contractions for completely escaping the chorion. Differences noted in the hatched fry under the influence of low magnetic field included: smaller embryos, decreased amount of yolk, stubbed tail, and severely curved vertebral column (scoliosis).

Previous studies have shown that the ability of *Fundulus* embryos to survive and develop in salt concentrations varying from distilled water to double strength sea water is dependent upon the integrity of their glycolytic mechanisms which supply the energy necessary to maintain the dynamic equilibrium of the system. Studies using marked ions established that linear transport in both directions occurs through the embryonic membranes. It was concluded from these experiments that the embryo maintains itself at an osmotic pressure of some 25% that of the surrounding medium because the active transport mechanisms are operating in both directions.

An experiment was conducted to determine the effect of glycolysis and/or the active transport mechanism by the low magnetic field. All embryos developing in salinities above 49 parts per thousand NaCl died within 24 hr after exposure to the low magnetic field. Anomalies occurred with approximately the same percentage rate for the surviving embryos as observed for the other experiments. These results suggest changes in the membrane structure or the biochemical reactions that influence the glycolytic and/or the active transport mechanisms.

Compiled data from this and previous studies indicate the need for further studies on the effects of low magnetic fields on other biological organisms and their life processes.

AMPHIBIANS OF NORTHEAST ALABAMA

L. G. Sanford
Jacksonville State University
Jacksonville, Alabama

The area of Alabama considered in this study constitutes approximately the northeastern one-fourth of the state. Amphibians have been collected from this area for the past 6 years through the combined efforts of the author and many students, primarily those in field or vertebrate zoology courses.

All of the 15 species of Anura reported in the literature from this area have been collected. These include *Gastrophryne carolinensis* (Holbrook), *Scaphiopus holbrooki* (Harlan), *Bufo americanus* Holbrook, *Bufo fowleri* Hinckley, *Hyla versicolor* Le Conte (may in actuality be *Hyla chrysoscelis*), *Hyla crucifer* Wied, *Hyla gratiosa* Le Conte, *Acris gryllus* (Le Conte), *Acris crepitans* Baird, *Pseudacris triseriata* (Wied), *Pseudacris brachyphona* (Cope), *Rana clamitans* Latrielle, *Rana palustris* Le Conte, *Rana pipiens* Schreber and *Rana catesbeiana* Shaw.

Eighteen of the 21 species of Urodela reported in the literature

from this area have been collected. These include *Cryptobranchus al-leganiensis* (Daudin), *Necturus alabamensis* Viosca, *Ambystoma opacum* (Gravenhorst), *Ambystoma maculatum* (Shaw), *Ambystoma tigrinum* (Green), *Notophthalmus viridescens* Rafinesque, *Desmognathus fuscus* (Rafinesque), *Desmognathus monticola* Dunn, *Desmognathus aeneus* Brown and Bishop, *Plethodon dorsalis* Cope, *Plethodon cinereus* (Green), *Plethodon glutinosus* (Green), *Aeneides aeneus* (Cope), *Gyrinophilus porphyriticus* (Green), *Pseudotriton ruber* (Latreille), *Eurycea lucifuga* (Rafinesque), *Eurycea longicauda* (Green) and *Eurycea bislineata* (Green). The other species of Urodela reported to occur in this area, *Necturus maculosus* (Rafinesque), *Desmognathus ochrophaeus* Cope and *Hemidactylium scutatum* (Schlegel), have not as yet been collected.

SEASONAL CHANGES IN SOIL TREHALASE ACTIVITY

Roger E. Smith and R. Rodriguez-Kabana
Department of Botany and Microbiology
Auburn University, Auburn, Alabama

In a 2-year study, the effects of fertilizer treatments and seasonal changes on trehalase activity (TA) in soil were investigated in a 3-year rotation system of cotton, corn-wheat, and soybeans. Ten plots of different fertilities were studied. Each plot received either complete fertilization (N, P, K, lime, and minor elements) or treatment deficient in one or more components. Seven plots received some N from winter legumes (vetch-crimson clover mixture). All treatments have been continuous for 11 years. Soil TA decreased under corn, wheat, and cotton, and increased under soybeans and winter legumes. Maximal TA occurred during active growth of soybeans and winter legumes and then declined. Other crops induced an increase in TA at maturity when released organic matter stimulated activity of the soil microflora. Seasonal levels of TA decreased in summer, increased in fall, remained at the fall-level through winter, and again increased in the spring. Seasonal responses in TA may be modified through crop influences. Addition of N to plots caused corresponding increases in TA, with N-deficient plots showing the greatest response. TA levels were higher in plots receiving triple superphosphate than in those receiving superphosphate. The addition of minor elements also caused increases in TA.

BLOOD CHANGES IN RABBITS INFECTED WITH *TRICHOSTRONGYLUS AFFINIS*

Jeanne J. Stuart and Carl F. Dixon
Department of Zoology-Entomology
Auburn University, Auburn, Alabama

Blood changes in rabbits parasitized by *Trichostrongylus affinis* were measured at intervals throughout 30 days of infection. Five inoculum levels consisting of 5,000; 10,000; 15,000; 20,000; and 25,000 infective larvae were administered to weanling or mature New Zealand white rabbits of both sexes. Oxyhemoglobin determinations, as a measure of developing anemia, showed no significant alterations in parasitized

Abstracts

animals throughout the study. In all experimental groups, packed cell volume showed 12th-day transitory elevations which correspond with the period of severe diarrhea associated with the presence of the parasites. Total protein values were not significantly altered at any infection level, but significant decreases in albumin and increases in gamma globulins were observed in both weanling and mature rabbits at all infection levels. The fact that anemic changes were not observed, together with the failure of total protein levels to be depressed, suggests that protein digestion and uptake are not seriously impaired in the presence of *T. affinis*.

A QUANTITATIVE STUDY OF REPRODUCTIVE MORTALITY ON CATTLE EGRETS, *BUBULCUS IBIS*, AND LITTLE BLUE HERONS, *FLORIDA CAERULEA*, NEAR CLIFTONVILLE, NOXUBEE COUNTY, MISSISSIPPI

Charles W. Summerour, III
Department of Zoology
Jacksonville State University
Jacksonville, Alabama

A quantitative study of mortality in Cattle Egrets, *Bubulcus ibis*, and Little Blue Herons, *Florida caerulea*, was conducted in a heronry near Cliftonville, Noxubee County, Mississippi, during the breeding season of 1970. Age-specific mortality was determined for both Cattle Egrets and Little Blue Herons through 9 weeks of age. In addition, data were obtained on laying intervals, clutch size and incubation periods.

Ninety-five Little Blue Heron nests totaling 410 eggs and 87 Cattle Egret nests totaling 322 eggs were sampled. Each egg was marked with a nest number and each nestling was color-marked at hatching and later banded.

Overall mortality in Little Blue Herons was 26.58% and 59.00% in Cattle Egrets. This highly significant difference was the result of mink predation which alone accounted for 23.60% of the Cattle Egret mortality as opposed to only 0.49% in Little Blue Herons. In all, mink accounted for over 200 Cattle Egret eggs or nestlings. Assuming no mink predation, Cattle Egret mortality would still have been somewhat higher than occurred in the Little Blues.

Egg mortality was 12.68% in Little Blues and 26.71% in Cattle Egrets, and nestling losses were 7.54% in Little Blues and 40.66% in Cattle Egrets. Of 331 Little Blue nestlings to leave the nest, 9.06% died or were killed before leaving the heronry as did 5.71% of the 140 Cattle Egrets.

Seven Cattle Egret eggs and 6 Little Blue Heron eggs were analyzed for pesticides and all were found to contain various amounts of DDT, DDE, DDD, BHC, HE, Dieldrin, and Mirex.

Nest construction required from 2 to 4 days in Cattle Egrets and 3 to 5 days in Little Blue Herons. A few Cattle Egrets made no nest and simply deposited their eggs in vacated Little Blue Heron nests.

Cattle Egret laying interval ranged from 1 egg per day until completion of the clutch to every other day or irregular intervals of 1 to several days between eggs. There appeared to be a tendency in Cattle

Egrets to lay delayed eggs from 5 to 23 days after completion of the apparent full clutch. Little Blue Heron intervals varied from 1 egg per day to irregular intervals of 1 to 2 days but never exceeded more than 2 days.

Clutch size in Little Blues ranged from 3 to 6 eggs with a mean of 4.4 ± 0.71 . One Little Blue Heron nest not in the sample contained 7 eggs. Cattle Egret clutch size ranged from 3 to 9 with a mean of 3.7 ± 0.56 .

Incubation periods in Little Blue Herons varied from 22 to 24 days with a mean of 23.1 ± 0.83 (plus or minus 1 day). Cattle Egret incubation period ranged from 23 to 24 days with a mean of 23.3 ± 0.52 days. Incubation began on the 1st egg in Cattle Egrets but usually started after the 2nd or 3rd egg in Little Blues and rarely after the full clutch was completed.

EFFECTS OF STREAM VELOCITY ON THE CONCENTRATION OF SOME HEAVY METALS DURING FLOWING SLUGS IN THE RESERVOIRS OF THE BLACK WARRIOR RIVER

Louis G. Williams
Department of Biology
University of Alabama, University

Water in the Black Warrior River was shown to be generally low in concentrations of Cd, Cr, Cu, Hg, Mn, and Zn, except during periods of flowing slugs following heavy rains. Muscle tissue of bluegill fish in the Warrior Reservoir contain levels of mercury exceeding the standards of the U.S. Pure Food and Drug Administration. A 60-mile long fish kill was followed from the Bankhead Reservoir, beginning on February 4, 1971, which was attributed to scuffed up bottom sediments heavily laden with heavy metals.

CHEMISTRY

PHYSIOCHEMICAL CHARACTERIZATION OF A MACROMOLECULAR PRODUCT OBTAINED FROM IMMUNOGLOBULIN M BY TRYPTIC DEGRADATION

Leven S. Hazlegrove and Ralph E. Schrohenloher
Samford University, Birmingham, Alabama
and
Division of Clinical Immunology and Rheumatology
University of Alabama, Birmingham

Degradation of human IgM by trypsin at 37°C yields products identified as $\text{F(ab)}_{2\mu}$ and Fab_{μ} fragments. Large quantities of material that sediment in the ultracentrifuge faster than the $\text{F(ab)}_{2\mu}$ fragment, but slower than the untreated IgM, are also present. Characterization of this partially degraded macromolecule (fragment A) was undertaken in this study. Fragment A was isolated from a Waldenström's IgM by gel chromatography after tryptic degradation for 16 hours at 37°C . Ultra-

Abstracts

centrifugal studies demonstrated that it sedimented with an $s_{20,w}^{\circ}$ value of 14.9S and had a molecular weight of approximately 600,000. The untreated IgM gave an $s_{20,w}^{\circ}$ value of 17.2S. Reduction of fragment A by cysteine followed by alkylation with iodoacetamide released a large quantity of material that could not be distinguished from the monomeric subunits of the untreated IgM with respect to sedimentation, molecular weight and reactivity with antisera specific for μ and κ chains. A small amount of 3S materials, consisting largely of an Fc_{μ} fragment, was also present after reduction. The Fc_{μ} fragment purified by DEAE cellulose chromatography, demonstrated a molecular weight of 37,000 by sedimentation equilibrium and gave reactions of identity with 7S subunits of the IgM when examined by double diffusion in agar with anti- μ antiserum. The results indicate that the degradation of IgM by trypsin proceeds by progressive cleavage of the subunits.

A STUDY OF PARTIAL MOLAL VOLUMES

Raymond Isbell and Larry R. Smith
Florence State University
Florence, Alabama

The purpose of this work was to develop a procedure suitable for use in an undergraduate physical chemistry laboratory for determining partial molal volumes. Both graphical and analytical methods were used. Procedures and calculations were done on two systems, one of acetone-water and the other of acetone-methanol. Equations for the curves were obtained by use of a computer. Differentiation of these equations is part of the procedure for determining the partial molal volumes.

ELECTRON-ELECTRON DOUBLE RESONANCE OF IRRADIATED ORGANIC SINGLE CRYSTALS

Lowell Kispert, Kichoon Chang and Carolyn Bogan
Chemistry Department
University of Alabama, University

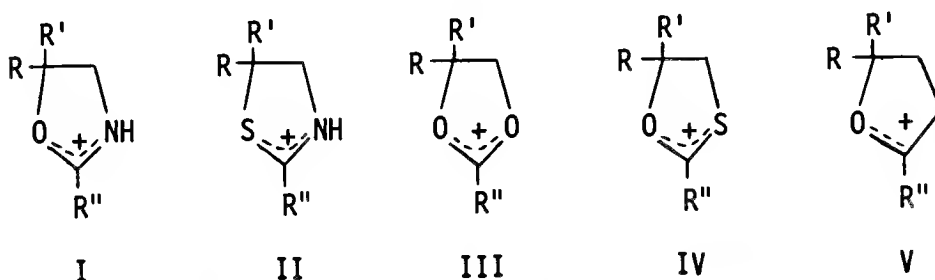
The interpretation of the esr measurements of irradiated organic single crystals can be made difficult or impossible by the presence of several radicals at a given temperature. In some cases annealing techniques or isotopic substitution methods have been used to simplify the esr spectra. Recently electron-electron double resonance (ELDOR) measurements [J. S. Hyde, L. D. Kispert, R. C. Sneed and J. C. W. Chien, J. Chem. Phys., 48, 3824 (1968)] have been shown useful in assigning the lines in complex esr spectra. An analysis of the ELDOR results for known radicals as a function of temperature has shown the conditions under which an ELDOR investigation can be useful in irradiation damage work. So far we have investigated the effect of rotating methyl groups, chlorine quadrupole coupling, nuclear spin exchange and fluorine hyperfine anisotropy on the relaxation conditions required for the observations of ELDOR in irradiated single crystals. When methyl groups are present a reduction in the esr intensity is observed above 10°C. However,

enhancement in the esr intensity is observed below 10°C, allowing a measurement of W_x , the cross relaxation probability, to be obtained. The presence of a chlorine substituent results in a simple two line ELDOR spectrum at $A^{35\text{Cl}}$ and $A^{35\text{Cl}} - \nu_{\text{Cl}}$ for the $\cdot\text{CClFCONH}_2$ radical, whose esr is very difficult to interpret. The presence of nuclear spin exchange in the CH_2COO^- radical shows a maximum in the ELDOR intensity when the exchange rate is equal to the esr line width. Fluorine anisotropy causes a drastic change with angle in the ELDOR transition probability. (This research was supported by the U. S. Atomic Energy Commission under contract No. AT-(40-1)-4062.)

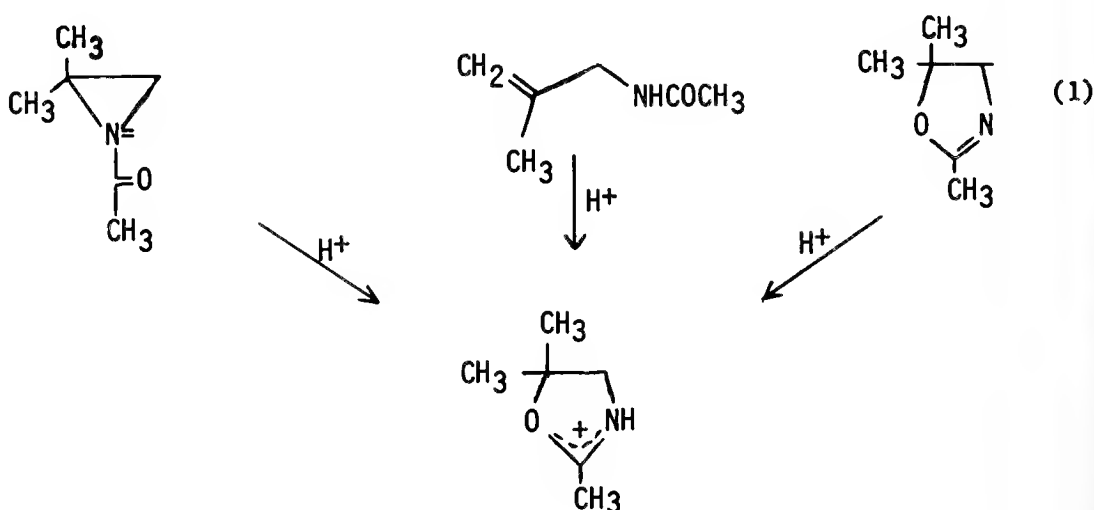
1,3-DIOXOLAN-2-YLIUM AND RELATED HETEROCYCLIC CATIONS

Samuel P. McManus
Department of Chemistry
University of Alabama, Huntsville

The formation of stable organic cations of the type I - V has been



realized where $R = \text{H}, \text{CH}_3, \text{phenyl}$; $R' = \text{CH}_3$; $R'' = \text{H}, \text{alkyl}, \text{aryl}, \text{OR}, \text{SR}, \text{NHR}$. Typical processes for forming I ($R = R' = R'' = \text{CH}_3$) are shown below in Equation (1). By studying the reactions with the aid of



nuclear magnetic resonance spectroscopy and H-D exchange studies, the reactions are found to occur through carbonium ion mechanisms followed

Abstracts

by cyclization to the carbonyl (or to the thiocarbonyl) group.

THE CHEMICAL EFFECTS OF THE CITY OF MONTGOMERY ON THE ALABAMA RIVER

Jim Pearson, Sue Wells, and F. A. Griffitts
Huntingdon College, Montgomery, Alabama

As part of Huntingdon College's independent study program, a group of chemistry students investigated by chemical analysis the nature of the Alabama River as it passes the city of Montgomery.

From January 3 to January 21, 1973, samples were taken daily above and below the city at points A and B approximately 30 miles (by river flow) apart. Using gravimetric, volumetric, complexometric, and spectrometric methods, analyses on samples A and B were made daily for the following: pH, chlorides, phosphates, ammonia, iron, hardness ions, suspended matter, soluble matter, turbidity, and total ionic strength.

Analytical findings for each test were checked by two students working independently and the data were recorded in chart form. A knowledge of the common ions which were suspected as pollutants, and the desirability for project completion by undergraduates working within the 15-day term, strongly influenced the choice of analytical tests to be made.

One factor, which had not been anticipated but which is suspected to have influenced results of the tests, was heavy rains that raised the water level some 35 feet and interfered with controlled sampling during the testing period. With this under consideration, results in general indicated that contaminants including chlorides, iron, phosphates, ammonia, hardness ions, suspended and soluble matter, along with contaminants contributing to the total ionic strength and to the acidity of the water, were appreciably higher in those samples taken below the city.

THE CRYSTAL STRUCTURE OF TRIMETHYL(QUINUCLIDINE)ALUMINUM

C. D. Whitt and J. L. Atwood
Department of Chemistry
University of Alabama, University

Trimethyl(quinuclidine)aluminum, $(\text{CH}_3)_3\text{Al} \cdot \text{NC}_7\text{H}_{13}$, was prepared by reacting trimethylaluminum with a benzene solution of quinuclidine, and its crystal structure has been determined from single crystal X-ray diffraction data collected by film techniques. The unit cell is monoclinic with $a = 8.94 \pm 0.02 \text{ \AA}$, $b = 10.66 \pm 0.02 \text{ \AA}$, $c = 6.84 \pm 0.02 \text{ \AA}$, $\beta = 106^\circ 19 \pm 10'$ and contains two formula units of the monomeric compound. The space group is $P2_1/m$. Approximately tetrahedral coordination is found about the aluminum atom and the aluminum-nitrogen bond is 2.06 \AA . Viewed along the aluminum-nitrogen bond, the methyl groups appear in a staggered configuration with respect to the methylene groups of the quinuclidine molecule.

Systematic absences indicated the space group to be centric $P2_1/m$ or acentric $P2_1$. The symbolic addition procedure of Karle and Karle was

used to determine the structure directly from the normalized structure factor magnitudes. The successful application of this direct method indicates the $P2_1/m$ structure to be correct. Least-squares refinement resulted in a final R value of 11.3% for the 675 visually observed reflections.

REACTIONS OF ALKYL HALIDES ON SILVER SULFAMATE

P. F. Ziegler
Department of Chemistry
Auburn University, Auburn, Alabama

Possibly, the first ester of sufamic acid was reported over 80 years ago, the trisubstituted ester, $ROSO_2NR_2$.

The simple monoester seemed to be difficult to prepare. The results of the reaction between the alkyl halide and silver sulfamate usually produce the N,N- disubstituted esters except for methyl sulfamate. All efforts using the homologous alkyl halides reacting with silver sulfamate on a mole for mole basis produced the trisubstituted ester as if alkylation of the N-atom was preferential. Traube, Zander, and Gaffron (1924) found similar results except in the reaction with benzyl halide in which the product was a disubstituted ester, benzyl N-benzyl sulfamate. They postulated that the reaction was influenced by the molecular weight of the alkyl radical and that a heavier radical would produce a simple ester.

This work investigated the reaction beyond the benzyl group. Interesting results revealed that the simple decyl and tetradecyl esters formed but always in a mixture of N-substituted esters. These and other results are discussed.

GEOLOGY

LITHOSTRATIGRAPHY OF THE CHICKAMAUGA GROUP AT BIRMINGHAM, ALABAMA

George F. Brockman
University of Alabama, Birmingham

The Middle and Upper Ordovician limestones in the Birmingham area are generally known as the Chickamauga Group. They unconformably overlies the Knox Group of dolomites, and are unconformably overlain by the Silurian Red Mountain Formation. The Chickamauga Group is lithologically and paleontologically heterogeneous, but previously published subdivisions and descriptions are not useful for a variety of reasons. The Chickamauga is here divided into seven lithologic units of formational rank. Of these, four are extensions of established formations from other areas, and three are new names.

The partially clastic basal beds are here called the Long Savannah Formation. This formation includes the Attalla chert conglomerates, and a number of shales, siltstones, impure limestones, and dolomites. Over-

Abstracts

lying the Long Savannah is about 200 ft of limestones that are equivalent to the Stones River Group of Central Tennessee, and are here termed the "Stones River (Undifferentiated) Limestone." These limestones probably include distinguishable equivalents of the Murfreesboro, Pierce, Ridley, and Lebanon Formations of Tennessee, but have not been subdivided in the present investigation. They are in turn overlain by the Carters Formation, which is almost identical to the Carters of the Central Basin. At Birmingham it is separated by a sizable unconformity from the Stones River Limestone, and by marked lithologic and faunal changes. It is therefore excluded from the Stones River here.

Three new formational names are proposed for the upper part of the Chickamauga Group. The Gate City Limestone consists of about 100 ft of slightly shaly, nodular to massive limestone that bears a Trentonian fauna. The Gate City is well exposed in the quarries at Gate City. The South Highlands Formation, named for exposures in the South Highlands section of Birmingham, includes about 15 to 25 ft of silty red-weathering medium-bedded limestone with thin interbeds of shale and fucoidal dolomitic limestone. The fauna of the South Highlands Formation suggests both Trentonian and Maysvillian components. The Spaulding Formation, with the type locality between Spaulding and Walker Gap on the north flank of Red Mountain, contains about 30 ft of thin-bedded limestone, dolomite, calcareous shales, sandstones, siltstones, and shale. It lithologically resembles the Sequatchie of other areas, and contains a Richmondian fauna. At the top of the Chickamauga Group in the Birmingham area is a thin discontinuous layer of typical Fernvale Limestone.

There is abundant evidence in the Chickamauga Group that the Birmingham area was undergoing mild deformation throughout the Middle and Upper Ordovician. Quite definite folding, with truncated beds and angular unconformities, can be seen at the contacts between the Stones River and Carters at Gate City and at Butler Mountain, between the South Highlands and Spaulding in the Mountain Terrace section of Birmingham and at Walker Gap, and between the Spaulding and Fernvale in most areas. There is evidence of uplift in the Gate City at Walker Gap, and of depression in the South Highlands in the vicinity of Red Mountain Expressway. The relationship between these mid- and late Ordovician structures and the later structures is not well defined.

PALEONTOLOGY OF THE CHICKAMAUGA GROUP IN THE BIRMINGHAM, ALABAMA AREA

G. F. Brockman and G. L. Bell, Jr.
University of Alabama, Birmingham

The Ordovician limestones in the vicinity of Birmingham were first subdivided by C. W. Butts in 1926, and since that time his description has generally been accepted. However, we found many inconsistencies between his descriptions and our field observations. Herein the Chickamauga Group is divided into seven formations based on faunal groups and lithology as described by Brockman, 1972.

The Long Savannah Formation is basal bed, resting on dolomites of Knox age. The formation is largely nonfossiliferous but contains *Lingulella fostermontensis* and some ostracods. Immediately above this

formation is the Stones River Limestone which generally is about 200 ft thick. These beds contain fossils that range widely in age. Equivalents of all the formations of the Stones River Group of Tennessee are probably present. The Carters Limestone at Birmingham does not belong with the Stones River Group. About 60 ft of Carters Limestone unconformably overlies the Stones River Limestone. The fauna resembles that of Tennessee, including *Tetradium cellulosum* and *Cryptophragmus antiquatus* in the Lower Carters and *Oxeplesia planulata*, *Sowerbyella subcarinata* and *Strophomena platyumbona* in the Upper Carters. The lithology is almost identical with the Carters of Tennessee.

With no apparent disconformity, the Carters grades into a series of shaly limestones that contain a likewise transitional fauna. These shaly limestones are included in the Gate City Formation, which in the Birmingham area is about 110 ft thick. The fauna from the basal shaly laminated nodular beds include *Dinorthis pectinella*, *Fascifera subcarinata*, *Glyptorthis bellarugosa*, *Opikina minnesotensis*, *Colaptomena leptostrophoidea*, *Ischadites iowensis* and *Tropidodiscus subacutus*. Higher in the formation the fauna becomes almost typically Trentonian, including *Flexicalymene senaria*, *Omniella fertilis*, *Paleocrinus striatus*, *Rhyncotrema increbescens* and *Platystrophia amoena*. The Gate City Formation is overlain by about 20 ft of somewhat silty limestone of the South Highlands Formation. A Trentonian fauna persists into the South Highlands. In places the upper few feet of this formation is made up of fucoidal limestone. The fauna within the South Highlands Formation includes *Hebertella sinuata*, *Platystrophia laticosta*, *P. ponderosa*, and *Orthorhynchula linneyi*. This is probably equivalent to the Liepers limestone of Tennessee. Other evidence also indicates later Maysvillian sediments may be present. The South Highlands Formation is disconformably overlain by the Spaulding Formation which attains a thickness of about 30 ft. These thinly bedded sediments contain a particularly good Richmondian fauna including *Isotelus iowensis*, *Lepidocyclus capax*, *Leptaena richmondensis*, *Omneilla meeki*, and *Sowerbyella clarksvillensis*. Overlying the Spaulding and separated by disconformity is a thin, discontinuous, and variable bed of Fernvale Limestone which is also of Richmond age. Above this is the Silurian contact.

PARAGENESIS IN THE JEFF PRICE MINE,
CAVE-IN-ROCK DISTRICT, ILLINOIS

John Robert Clark
University of Alabama, University

Polished "thick" sections were used to determine the paragenetic sequence in each of five areas within the Jeff Price Mine. Blue, purple, and yellow growth bands in fluorite are sufficiently distinct and continuous to serve as indices upon which the depositional history of other minerals may be related. Minor paragenetic differences occur in each of the five areas, but sufficient similarities exist to allow proposal of the following, general paragenetic sequence: calcite, purple fluorite, milky clear to milky yellow fluorite, with chalcopryrite, yellow fluorite with massive sphalerite, light yellow fluorite, purple fluorite, yellow or clear fluorite, light blue or blue-green fluorite,

Abstracts

purple fluorite, blue fluorite, purple fluorite, calcite and barite.

VOLCAN La SOUFRIERE, GUADELOUPE

Otis M. Clark, Jr.
Geological Survey of Alabama

Guadeloupe is a twin island near the center of the island arc forming the Lesser Antilles. The western island, Basse Terre, is mountainous, composed of volcanic extrusions and contains an active volcano. The eastern island, Grande Terre, is a low dissected plain made up of limestone.

The volcano, La Soufriere, the highest peak on the island, is composed of predominantly volcanic ash and flows. There is no large central crater exposed on the surface. Sulfur-bearing hot gases reach the surface by diffusing upward through ash beds. Many vents are in a line, which apparently is controlled by faulting. Sulfur crystals have precipitated on the surface rocks where hot gases escape. Rock samples were collected and tested for heavy metals. Results were inconclusive; additional research on vulcanism and ore deposition is needed.

MUDCRACK SYSTEMS AND THEIR ORIGIN

Steve Dickens
Department of Geology
Auburn University, Auburn, Alabama

Very little has been done in the field of classifying and describing the origin of different freshwater mud crack systems. It is the purpose of this research to differentiate and classify some of these systems. The flat where this study took place is southeast of the intersection of U.S. 29 and I-85, Lee County, Alabama.

There are four main mud crack systems that could be easily separated, namely: 1) large scale mud polygons, 2) small scale mud polygons, 3) superimposed mud cracks, and 4) sheet cracks.

The relative significance of determining factors was studied. The most significant factor in all four systems is desiccation. The secondary factors include: 1) vegetation, 2) grain size differentiation, 3) rate of desiccation, 4) relative thickness of muds, and 5) burrowing.

THE STRUCTURAL SIGNIFICANCE OF APOLLO IMAGERY

James A. Drahovzal and Thornton L. Neathery
Geological Survey of Alabama

Additional follow-up studies of Apollo 9 photography in east-central Alabama and ground-truth geological investigations have led to some new interpretations of the earlier discovered lineaments. Two of the lineaments discovered appear to be geographically more significant than the others in that they 1) are of great geographic extent (one may be nearly

250 miles long); 2) intersect Appalachian structural axes at points of lateral offset, termination or change in structural style; 3) show a possible relationship to stratigraphic changes; 4) coincide with areas of known mineralization; and 5) appear to coincide with earthquake epicenters. All of these factors suggest that lineaments may represent geofractures that bound basement blocks and that differential vertical movement may have characterized the basement from the Early Paleozoic to the present day. The thin-skinned structures of the Appalachians may then be understood as an overprint response to the vertical movements. Such a model, if correct, is significant to the understanding of Appalachian regional geology. (Approved for publication by the State Geologist, Geological Survey of Alabama.)

THE EFFECTS OF CHANGING PATTERNS OF SEDIMENTATION
ON THE ECOLOGY OF OYSTERS, LITTLE
DAUPHIN ISLAND, ALABAMA

Conrad A. Gazzier
University of South Alabama, Mobile

Aerial photographs through the years show that the shorelines of Dauphin Island Bay have undergone extensive sedimentary alteration in the last 30-35 years. This alteration has resulted in destruction of the oyster environment in many parts of the area, and seems to be the direct result of man's activity in this sensitive, estuarine environment. Dredging, filling and construction have formed new sources of sediment, and at the same time have altered the local currents, so that the sediments have been distributed over areas not previously affected. This has caused further changes in the currents, altering the salinity, sedimentation and circulation. Even minor changes in these ecological factors have had detrimental effects on the local oyster population.

POSSIBLE MECHANISMS FOR THE DEPOSITION OF IRON IN
THE RED MOUNTAIN FORMATION OF ALABAMA

Oscar E. Gilbert, Jr.
University of Alabama, University

Previous theories explaining development of the Red Mountain iron ores by secondary alteration have been rejected, the conclusion being drawn that the ores are original sedimentary components of the formation.

The method of deposition is dependent upon the means of transport of iron in the stream environment; therefore, various theoretical means of transport and their depositional characteristics have been compared to actual data. Iron (II) bicarbonate ion, Fe (III) oxide coatings of clay minerals, and chelates have been rejected as methods of transport on the basis of available theoretical and experimental data. Iron (III) hydroxide colloids, which are precipitated as flocculant lumps by electrolytes in solution, will account for the disseminated hematite (Hickery Nut seam) type ores, but will not account for the oolitic or replacement ores.

Abstracts

The theory of Fe (II) ions in true solution transport was introduced in 1950 by Castano and Garrels, and their experimental data indicated that this method would account for the oolitic and replacement type ores. However, experimental evidence indicates that Fe (II) ions are not stable under the Eh-pH conditions of natural surface environments. Theoretical stability fields indicate that the iron is probably present as one or more complex Fe (II) hydroxide ions is normal, slightly acidic surface waters. The proper Eh-pH ranges for these ions closely coincide with measured values for modern streams and lagoons.

It is concluded that the iron was introduced into a Silurian lagoon as complex Fe (II) hydroxide ions, with the intermixed clastics settling out in the lagoon. Iron rich-clastic poor water spilling over the barrier islands, which were roughly parallel to the present Birmingham Anticlinorium, encountered open sea water in equilibrium with carbonate. The resulting pH increase resulted in the iron being oxidized to insoluble Fe (III) hydroxides and precipitated as coatings and replacement on carbonate particles, as well as flocculant lumps.

SOLID WASTE DISPOSAL: A COMMUNITY CRISIS

Kendall Hanby and Leon Scarbrough
Geological Survey of Alabama

Solid waste disposal has become an important part of present day life. The task of disposing of garbage is not as simple as it was a few years ago. Only thorough planning and application of sound engineering principles to all stages of site selection, design, and operation will result in a successful and efficient sanitary landfill. To meet this objective, it is essential to have an understanding of the methods of operation, the decomposition processes, the decomposition products, and the hazards that exist from the decomposition products. This paper reviews the basic principles of construction, decomposition, maintenance, and safeguarding measures being used in early 1972 to satisfy these objectives. The role of the engineer and geologist working closely with civic leaders is one key to successfully safeguarding our natural resources. (Publication authorized by the State Geologist, Geological Survey of Alabama.)

DELINEATION OF LITHOFACIES WITHIN THE MOOREVILLE-BLUFFTOWN FORMATIONS OF SOUTHEASTERN ALABAMA

Nancy Meroney
Department of Geology
Auburn University, Auburn, Alabama

Since 1894 a major east-west facies change has been acknowledged within the Upper Cretaceous Selma Group of the Coastal Plain of Alabama. The scope of this report involves the study of the transition between the calcareous and clastic sequences occurring within the Blufftown Formation and Mooreville Chalk in Montgomery, Macon, Bullock, and Russell Counties, Alabama and adjacent Georgia counties of Chattahoochee,

Marion, and Stewart.

Lithologic relationships were primarily determined by construction of two fence diagrams based on well log descriptions. These relationships were then supplemented by carbonate, grain size, and organic content analysis of samples collected in Russell and Montgomery counties.

These data revealed six distinct lithologic units: an eastern sand body, two separate sandy clay bodies, a southern body of calcareous clay, a western body of sandy marl, and an impure chalk unit. The sand body represents two different environments. The easternmost extension of the sand body, located 20 miles east of the present Chattahoochee River, clearly was closest to the source of the clastics and appears to have been deposited in a semi-protected nearshore marine environment. The western extension of the sand resembles barrier bar deposits. The clay bodies represent protected embayments. To the west the sediments become more micritic. The calcareous clays represent a transitional lithology between fine-grained clastics and fine-grained carbonates. The carbonate lithologies, sandy marl and chalk, indicate a transition to non-clastic conditions.

ROCK MOVEMENT OF THE POTTSVILLE--NORTHERN CULLMAN COUNTY

Paul H. Moser
Geological Survey of Alabama

A 15-meter-deep cut on Interstate 65 in northern Cullman County exposes a massive sandstone unit overlying a dark gray shale unit in the lower Pottsville. Since construction of the Interstate in about 1965, the upper sandstone unit has moved away from the hill, and toward the highway in relation to the underlying shale. Total horizontal displacement is a maximum of approximately 50 centimeters.

Drill hole impressions in the sandstone continue uninterrupted in the shale and verify horizontal and a small degree of longitudinal displacement. The following factors are considered active in this movement: (1) Removal of large amounts of rock for construction of the interstate has permitted an "unloading" of the sandstone, and movement away from the hill. (2) Removal of the overburden has permitted the underlying shale to dry out, and normal desiccation caused this unit to shrink in volume and recede toward the hill. (3) Water percolation through the sandstone lubricates the shale, providing a slick surface for movement to take place. (4) Vibrations due to blasting have probably triggered movement along the sandstone-shale contact. (Approved for publication by the State Geologist, Geological Survey of Alabama.)

NOTES ON THE STRATIGRAPHY OF THE HILLABEE CHLORITE SCHIST IN THE NEW PIEDMONT STRATIGRAPHY

Thornton L. Neathery
Geological Survey of Alabama

Recent mapping in the northern Alabama Piedmont indicates that much of the metamorphic section is a "normal" stratigraphic succession. A

Abstracts

key marker horizon, the Hillabee Chlorite Schist, has been previously mapped as an intrusion along a large fault. Regional geologic studies indicate, however, that the Hillabee is the uppermost member of a complex volcanic-clastic sequence. This sequence was originally composed of felsic and mafic tuffs, marine shales, cherts, basalts, and large mafic bodies of basaltic composition. Various degrees of metamorphic and tectonic overprint have altered these original lithologies to chlorite phyllite and fine-grained schist, sericite-quartz schist, sericite quartz schist, and greenstone. The greenstones range from fine-grained massive epidote-chlorite-amphibolite schist to coarse-grained rocks of gabbro or norite composition. Metamorphic grade for the entire sequence ranges from the quartz-albite-muscovite-chlorite subfacies of the greenschist facies to the staurolite-almandine subfacies of the almandine-amphibolite facies.

The various components of the volcanic-clastic sequence inter-tongue along strike, apparently grading from one lithology to another. The Jemison Chert appears to grade stratigraphically upward and laterally into a fine-grained meta-argillite which in turn grades laterally into sericite-quartz schist containing irregular inclusions of chlorite-actinolite schist. Northward along strike the chlorite phyllite and fine-grained schist becomes the dominant member of the sequence and appears to become more siliceous and coarse-grained in Cleburne County. Greenstone of the Hillabee caps the entire sequence and interfingers with the overlying Wedowee Group. Similar lithologies occur as lenticular bodies in the lower members of the sequence. In the southwestern part of the outcrop area, near the Coosa River, these greenstones are calcic-rich.

The volcanic-clastic sequence appears to represent a transitional stage between an underlying shallow marine-fluviatile-deltaic environment and a similar overlying but more carbonaceous complex. The volcanic material was introduced into a shallow marine environment terminating the depositional cycle by diluting and contaminating normal marine lithologies until they were replaced by volcanic affinities. Culmination of the volcanic activity resulted in the intrusion of basaltic rocks. Late Paleozoic tectonism has locally thrust the Wedowee over the volcanic-clastic sequence, often cutting out large parts of the upper member. (Publication authorized by the State Geologist, Geological Survey of Alabama.)

NEW DATA ON THE NATURE OF THE ASHLAND HILLABEE CONTACT IN CLAY AND COOSA COUNTIES, ALABAMA

John W. Reynolds
Geological Survey of Alabama

Recent data from the northern Alabama Piedmont have shed new light on the nature of the contact between the Hillabee Chlorite Schist and metasediments of the Wedowee Group, and on the interrelationship between these two horizons. Stratigraphic and petrographic studies indicate that the Hillabee Chlorite Schist within northern Chilton, Coosa and Clay Counties forms a regularly bedded gradational stratigraphic unit apparently underlying the Wedowee Group equivalents. This gradational contact spans a distance of at least one-half mile and involves an interbedding

of pelitic units with mafic units of Hillabee affinity. The relative abundance of interbedded Hillabee-type mafic units within the Wedowee equivalents increases regularly as the stratigraphic top of the Hillabee is approached. Pelitic units of the Wedowee contain a significant increase of constituent mafic minerals near the Hillabee contact.

Hillabee-type lithologic units within the Wedowee continue across a steep metamorphic gradient present within the Wedowee outcrop area, separating low metamorphic grade Wedowee equivalents from those of high metamorphic grade. The Hillabee-type lithologies exhibit Barrovian-type metamorphic facies ascension across this gradient, changing from a chlorite-actinolite schist into a garnetiferous banded amphibolite. No direct evidence of major faulting is associated with the contact or within the adjacent Wedowee. No evidence indicating an igneous intrusive origin for the Hillabee or the Hillabee-type interbedded units was noted. "Genetic models" which explain the observed relationship include: 1) an origin of the Hillabee as a bedded pyroclastic sequence in gradational conformable contact with overlying pelitic Wedowee equivalents, and 2) an origin of the Hillabee as a metamorphosed carbonate horizon in gradational conformable contact with the overlying Wedowee. (Approved for publication by the State Geologist, Geological Survey of Alabama.)

QUATERNARY GEOLOGY OF THE ALABAMA RIVER AREA, ALABAMA

Michael W. Szabo
Geological Survey of Alabama

The Alabama River heads in south-central Alabama at the confluence of the Coosa and Tallapoosa Rivers and ends in southwest Alabama where it becomes a tributary of the Mobile River. The river is a degradational stream that has been interrupted seven times during its incisement by climatically induced changes in its hydraulic regimens. These changes produced fluvial sediments occurring as vertical lithologic sequences grading from basal gravel to topmost silt or clay that were left as indications of the erosional history of the stream. The sediments occur in the present flood plain that is being abandoned and six terrace levels representing alluviation and abandonment of six ancestral flood plains by the river during the Pleistocene. The top four terrace levels represent deposition following periods of incisement accompanied by lateral shifting, and the lowest two terraces and the flood plain represent deposition and incisement within valleys aligned along the same general axis as the present channel of the Alabama River.

The first four terraces represent valley widening and alluviation with climatic variations that occurred at the onset of the Nebraskan, Kansan, Illinoian, and Wisconsin periods of continental glaciation. The remaining levels of deposition represent valley widening and alluviation produced by climatic fluctuations associated with the waxing and waning of the Wisconsin continental glacier. (Approved for publication by the State Geologist, Geological Survey of Alabama.)

Abstracts

MINERALOGY OF ALABAMA BENTONITES

W. Everett Smith
Geological Survey of Alabama

X-ray diffraction and DTA data on Alabama Ordovician and Cretaceous age clays having lithologic characteristics similar to bentonite are discussed and compared with data on bentonites elsewhere in North America. Dominant mineral constituents of Alabama Ordovician bentonites are mixed layer illite-muscovite (1 Md, M) -- montmorillonite, with illite-muscovite predominant. This is consistent with data on Ordovician bentonites elsewhere in North America. Minor amounts of quartz occur in all clays studied. Biotite (detrital) occurs in the Cretaceous bentonite and in some of the Ordovician bentonites. Dominant mineralogy of Cretaceous bentonite is montmorillonite, quartz, biotite and kaolinite. High temperature accessory minerals including lepidomelane, spinel, euhedral apatite and zircon occur in one sample of Ordovician bentonite and may be present in other Ordovician bentonites. (Approved for publication by the State Geologist, Geological Survey of Alabama.)

THE ENVIRONMENTAL SIGNIFICANCE OF THE TOMBIGBEE SAND AT MONTGOMERY, ALABAMA

Ronald S. Taylor
Department of Geology
Auburn University, Auburn, Alabama

The uppermost deposits of the Eutaw Formation in the southeastern Montgomery area display several features that are characteristic of modern surf zone deposits. Among the sedimentary features that are consistent with a surf zone interpretation are: (1) dominance of well-sorted medium-grained sands, (2) thick, tabular cross-bed sets with cross-beds that dip parallel to the ancient shoreline, (3) thin cross-lamination sets with laminae that dip perpendicular to the ancient shoreline, (4) a nearshore fauna dominated by burrowing cassiduloid echinoids, and (5) longshore bars capped by callianassid burrows.

The most revealing study site is a hill near the Montgomery Industrial Terminal, the top and slopes of which have been excavated leaving a block-like exposure consisting of cross-bedded sand capped by massive sandstones. The lateral dimensions of the rectangular exposure are approximately 100 by 200 ft and its thickness varies from 5 to 20 ft.

Three sand bodies were differentiated into two parallel sand bars of similar dimensions separated by the fill of a shallow trough. A continuous cover of massive sandstone caps these three cross-bedded sand units.

A METHOD FOR DETERMINING THE SIZE AND SHAPE OF WATER PRODUCING
CAVITIES IN KARSTIC LIMESTONE

Kenneth E. Vanlier and Paul H. Moser
Geological Survey of Alabama, University

Many large-capacity wells in northern Alabama tap solutionally enlarged cavities in karstic limestone. The height of cavities penetrated by wells can be determined by drill action when wells are drilled and by the use of bore hole caliper devices after well completion. The length and width of large cavities, however, cannot be determined by conventional bore hole-logging devices.

The configuration of water-filled cavities tapped by wells in northern Alabama has been measured with a sonar device. The device, an adaptation of a fathometer, measures under water distances through sonic echo ranging. It is lowered into a well on a string of rods. Measurements taken every 20 to 30 degrees at 1-ft depth intervals provide data on size and shape adequate for the appraisal of possible origins of cavities and the trends of fracture systems that influenced their development. The device used in Alabama is capable of measuring distances ranging from 1 to 200 ft. The sonic beam generated by the device expands with distance, hence its sensitivity for distinguishing small features decreased with distance. The device can be used in wells as small as 4 inches in diameter.

FORESTRY, GEOGRAPHY, AND CONSERVATION

DEVELOPMENT AND TESTING OF RESIDENT WATERFOWL
PROPAGATION AND RELEASE TECHNIQUES

J. H. Burbank
Tennessee Valley Authority

Tennessee Valley Authority entered into a 10-year cooperative study in January, 1971, with the Tennessee Game and Fish Commission to establish a principal propagation facility and thereby foster the development of resident breeding flocks of Canada geese and other waterfowl species in Tennessee and other parts of the Tennessee Valley. Purpose of the project is to supplement and complement the natural supply, distribution, and use of the region's waterfowl resource with resident species of ducks and geese. Initially, the work centers on two species: The giant race of Canada geese (*Branta Canadensis maxima*) and the wood duck (*Aix sponsa*). The propagation facility is being developed at the state's Buffalo Springs Game Bird Research Farm in Grainger County near Rutledge, Tennessee.

Canada geese were purchased from private sources in Alabama, Michigan, and Illinois; the Bureau of Sports Fisheries and Wildlife donated birds from their research facility, the Northern Prairie Wildlife Research Center, Jamestown, North Dakota. Present flocksize is 156, 51 of which are 2-year birds hatched during the 1971 breeding season. The 110 wood ducks on hand came from birds donated to the state by Region

Abstracts

4, Bureau of Sports Fisheries and Wildlife.

This season 30 pairs of known breeding Canada geese are being kept in individual 12- by 25-ft pens wherein nesting structures, food, grit and water are supplied. First clutches will be taken for artificial incubation and pairs will be encouraged to renest. Renesters will be permitted to raise their second clutches. Up to 200 goslings could be produced this year. The goal is to have 50 known breeder pairs available for individual pen handling by the 1973 breeding season, from which 300-350 goslings could be raised annually.

Fifty pair of wood ducks are being kept in smaller 6- by 6-ft individual pens. These birds will be permitted to raise first clutches, although in future years artificial incubation techniques will be tried.

Plans for the first joint releases by the Tennessee Game and Fish Commission and TVA are underway. Probable candidates for Canada goose releases are Melton Hill Lake near Oak-Ridge, Tennessee, and Land between the Lakes, TVA's outdoor recreation conservation education facility near Paducah, Kentucky. Wood duck release plans are incomplete at this time due to the unpredictability of the hatch.

THE RIVERTON-ROSE TRAIL

Freda Smith Daily
Florence State University
Florence, Alabama

This paper describes activities of people of the Riverton-Rose Trail of Colbert County, Alabama from prehistoric times to the present. The physiographic features of this region of Alabama caused the land to be particularly valued through the centuries by its inhabitants. Because of its location at the foot of Colbert Shoals, the first major obstacle to navigation of the Tennessee River from its mouth on the Ohio River (a distance of 226 miles), Riverton served as a river port and trade center during the summer months when Colbert Shoals was too shallow to navigate.

The highpoint of the economic history of this area came during the boom period of 1890-1915 when a British speculator unsuccessfully tried to make a manufacturing center of the little town then located here.

The Colbert Shoals Canal, designed by Captain George W. Goethals with the highest single lift lock in the United States when it was completed in 1911, spelled the end for Riverton as a port for it provided safe passage over the treacherous shoals at all seasons. Completion of Pickwick Dam in 1938 by the Tennessee Valley Authority buried the town beneath the deep quiet waters of Pickwick Lake.

Today the people of this area love its quiet beauty and are working through the Riverton-Rose Trail Association, organized in 1969, to develop the area as a recreation haven for the people living in nearby urban areas.

OCCUPATIONAL TRAINING IN TIMBER HARVESTING
IN NORTH ALABAMA

John H. Hinton, Jr.
Tennessee Valley Authority
Muscle Shoals, Alabama

The occupation of logging is being upgraded due to several forces. First, the lack of available labor has forced the industry to turn to mechanical assistance. Second, public concern over wanton destruction of the forest environment is having a pronounced effect on timber harvesting practices. Third, the rapidly increasing demand for wood products and products derived from wood is taxing the ability of the industry to produce wood at a rate that will meet the need. All of these forces dictate that timber harvesting must now be performed by a more competent person—a person who knows the capabilities and limitations of expensive, sophisticated equipment; a person who understands the interdependence of wild life and plant life and how to maintain this relationship; a person with business ability and thorough understanding of human relations. To assist the young, enterprising individual interested in this occupation, several schools, training sessions, and demonstrations are available for his benefit.

THE LIVING UNIVERSE: A HYPOTHESIS

John Wilson Kilburn
Jacksonville State University
Jacksonville, Alabama

This paper offers a hypothesis for testing based upon the Living Universe theory. The basis for this theory is that the heavenly bodies—i.e., the planets and stars—act in many ways like the cells of living tissue. Using this theory, most of the observed phenomena at the earth's surface can be explained; also, it can account for the multitude of heavenly bodies by the process of mitosis. Thus, many of the forces at work in the micro-world are at work in the macro-world.

DETERMINING LAND USE OF MARSHALL COUNTY
BY AERIAL PHOTOGRAPHY

Merilyn Osterlund
University of Alabama, Huntsville

An efficient and successful method of determining present land use is essential to the effective utilization of an area's resources. One such method is through the interpretation of aerial photography. In 10 to 20 hours an aerial photo interpreter can determine with a high degree of accuracy present land use of an area by a U.S.G.S. 7½' quadrangle.

Abstracts

CAYMAN ISLAND RESEARCH PROJECT: PLANT DISTRIBUTION

Glenn R. Sebastian
Department of Geology/Geography
University of South Alabama, Mobile

The Cayman Islands, British West Indies, are situated in the Caribbean Sea, 160 miles south of the Cuban shoreline. Cayman Brac, the second largest of the group, tends to exhibit the most diverse physical environment, and it was the center of investigation discussed in this paper.

Cayman Brac is part of the Cayman Ridge, which is part of a marine extension of the Sierra Maestra of Cuba. The Tropical Wet and Dry Climate (Aw) is the dominant climatic type, influencing the size and density of plant life, but not distribution. The soils are of the aluminous lateritic type over limestone - having a marked effect on plant distribution.

Plant distribution on Cayman Brac is most unusual for an island comprising only 14 sq miles. The west end of the island possesses a dense mangrove swamp and in many areas a dense jungle-like appearance. The east end of the island, which exhibits a 140-ft cliff, possesses a very arid, sparse vegetation. The drought resistant qualities of the plant life are very noticeable. Geology is the only variable which properly explains this plant distribution of Cayman Brac. The height of the landscape, coupled with the porous nature of the underlying rock structure, prevents water retention near the surface. In this case, the only time the plants receive moisture is during the actual period of rainfall.

A COMPARISON OF YELLOW-POPLAR, LOBLOLLY, AND VIRGINIA PINE IN SOUTHERN CUMBERLAND PLATEAU PLANTATIONS

Glendon W. Smalley and Kenneth Pierce
U. S. Forest Service, Silviculture Laboratory
Sewanee, Tennessee

The intensity of forest management is increasing and foresters need information about the performance of commercially valuable species on the wide array of sites existing on the Cumberland Plateau.

The survival and growth of three species planted on north-facing slopes were compared after 10 years. Survival was 72% or greater for all species on ridges and slopes. In the bottoms 69% of the loblolly, 61% of Virginia pine, and 56% of yellow-poplar survived. Loblolly averaged 32.8 ft in height and 5.4 in. in diameter; Virginia pine was 27.5 ft and 4.5 in.; yellow-poplar was 21.9 ft and 2.2 in.

Loblolly outgrew Virginia pine on all topographic positions. The height growth patterns of the pines were nearly linear. Yellow-poplar was shorter than all except Virginia pines on all lower slope positions. Herbaceous and woody competition reduced the growth of poplar in the bottoms.

In terms of height, yellow-poplar was most sensitive to topographic position, loblolly was intermediate, and Virginia pine least sensitive.

Loblolly is the preferred species in managing existing stands on north slopes, ridges with deep soils, and in well-drained bottoms. Virginia pine grows reasonably well on a variety of sites and is probably better suited than loblolly to warm slopes and sites with shallow soils. Although its performance was not very good in this study, there is ample evidence that yellow-poplar may grow as well as loblolly on lower slopes and in bottoms.

PHYSICS AND MATHEMATICS

LIGHT OF THE FUTURE: FUSION POWER

Raymond F. Askew
Physics Department
Auburn University, Auburn, Alabama

The current rate of consumption of fossil fuels, particularly for the generation of electric power, will exhaust within a century all known reserves which can be utilized at reasonable costs. Additional drains on these reserves can be expected as the currently underdeveloped nations attempt to move toward at least a modest degree of industrialization. If economic stability is to be maintained and if standards of living are not to be reduced below current levels, new sources of energy which are economically feasible must be utilized. Presently, power from nuclear fission reactors offers some hope but only if adequate supplies of nuclear fuel can be maintained and these must be manufactured.

The greatest source of potentially available energy could come from nuclear fusion using deuterium as the basic fuel. The known accessible supply of deuterium on earth would provide sufficient energy for a period exceeding the sun's lifetime, if this energy could be extracted and harnessed. Thermonuclear reactor systems hold the potential for solving the world's energy needs.

KINEMATICS OF NUCLEAR REACTIONS

Robert T. Carruth
Auburn University, Auburn, Alabama

The use of the invariant square of the four-momentum in the transformation from one Lorentz frame to another is presented. This is followed by a discussion of the application of this technique to the study of the breakup fragments of carbon-12 nuclei excited by absorption of negative ions from rest.

Abstracts

THE STRUCTURE OF THE ATMOSPHERE IN THE LOWER TROPOSPHERE AND THE MID-STRATOSPHERE AS DELINEATED BY THE WIND PROFILE

Oskar M. Essenwanger
Physical Sciences Directorate
U. S. Army Missile Command
Redstone Arsenal, Alabama

Usually the general circulation of the atmosphere is studied by consideration of the horizontal field at the surface or upper air. Although the large scale structure divided into Hadley Cell, subtropical-midlatitude branch and polar (anticyclonic) eddy takes into consideration the vertical motion, the vertical structure as portrayed by the wind speed is seldom utilized.

The author has recently examined this vertical structure by a mathematical representation of the windspeed as a function of altitude. This research provided the result that the wind profile from surface to 25 km can be reduced to

$$V_h = A_j [1 + k_1 \sin(\alpha_h + \beta_1) + k_2 \sin(2\alpha_h + \beta_2) + k_3 \sin(3\alpha_h + \beta_3)].$$

Analogously one finds for the lower layer from surface to 3 to 5 km

$$V_h = C_j [c_0 + \phi_{1h} + c_2\phi_{2h} + c_3\phi_{3h} + c_4\phi_{4h}].$$

While the k_1 and c_1 denote constants varying only by month and location (the ϕ_{1h} represents orthogonal polynomials), we find the A_j and C_j as the only time variables left.

Since correlations between atmospheric layers are mostly investigated by level characteristics of individual elements, it was tempting to probe the relationship between the lower troposphere and the mid-stratosphere by these characteristic variables, which summarizes layers rather than levels. Correlation coefficients between these characteristic variables have been calculated for 4 typical stations (Albrook, Canal Zone; Montgomery, Alabama; Chateauroux, France; and Thule, Greenland) of 4 individual climatic regions. They show a strong linear relationship between the lower troposphere and total structure of the wind profile up to 25 km in the subtropical and midlatitude regions. This correlation is far above the level of expectation for the spurious correlation coefficient. In the polar regions a close relationship exists only in summer, decreasing considerably in winter. This behaviour may indicate the independence of the polar vortex in the lower layers from the circulation above it. The correlation is also virtually nonexistent in the tropical zone. The same pattern emerges for the comparison of the surface to 3 km layer with the entire layer up to 25 km, although the correlation is somewhat weaker in the average. In the areas of weak linear correlation a non-linear correlation does not improve the result.

As a by-product, at least in the zones and seasons with strong correlation, the wind profile data can be supplemented in the upper layers with the aid of a correlation technique, and data bias caused by the loss of measurements in the upper layers can at least be partially corrected if not completely eliminated.

NUCLEAR PREIONIZATION OF HIGH PRESSURE GAS LASERS

Faison P. Gibson
U. S. Army Missile Command
Redstone Arsenal, Alabama

In certain gas laser devices the gas medium is first preionized by electron guns and then a high voltage gas discharge is produced which provides the energy for pumping the laser. The question arises whether means other than electron guns might be effectively employed for preionization. We have made estimates of the rate of creation of ion pairs by various nuclear radiation schemes. Neutron beams from nuclear reactors and fission gamma rays from a pulsed reactor appear to have possibilities for obtaining practical levels of preionization.

UNISOR: UNIVERSITY ISOTOPE SEPARATOR AT OAK RIDGE

E. L. Robinson
Department of Physics
University of Alabama, Birmingham

A new laboratory facility nearing completion is described. An on line isotope separator which will be used in conjunction with the Oak Ridge Isochronous Cyclotron will facilitate the rapid separation by mass of radioactive isotopes produced in the separator's ion source by beams of high energy heavy ions from the cyclotron. Although there are several on line isotope separators in use throughout the world, only one other has heavy ion beams available. It is anticipated that many radioisotopes far from stability will be produced and their decays studied. The program is operated by a consortium of the University of Alabama in Birmingham, Georgia Institute of Technology, Emory University, Furman University, University of Kentucky, Louisiana State University, University of Massachusetts, University of South Carolina, University of Tennessee, Tennessee Technological University, Vanderbilt University, Virginia Polytechnic Institute and State University, Oak Ridge Associated Universities and Oak Ridge National Laboratory. It is supported by these institutions and the U. S. Atomic Energy Commission.

X-RAY FLUORESCENCE DETECTOR FOR ELEMENT ANALYSIS
AND ORGAN SCANNING

E. L. Robinson
Department of Physics
University of Alabama, Birmingham

A new system using x-ray fluorescence for thyroid scanning is described. The system uses well collimated gamma radiation from an external radioisotope source to stimulate characteristic iodine x-rays in the stable iodine in the patient's thyroid. These x-rays are detected by a high resolution silicon x-ray detector. The patient is given no radioactive material and the total radiation dose to which he is exposed is

Abstracts

substantially lower than that received by patients dosed with radioactive iodine or technetium for conventional thyroid scans. The similarities and differences of the information derived from fluorescent scans and conventional scans are discussed. Use of such systems for analysis of other elements is discussed.

ISOTOPE EFFECT ON THE U-BAND IN CESIUM HALIDES

R. A. Shatas and G. A. Tanton
Quantum Physics, Physical Sciences Directorate
Redstone Arsenal, Alabama

H⁻ and D⁻ ions enter as substitutional impurities into alkali halide and alkaline earth halide crystals and occupy the site of the halogen ion. The presence of these substitutional impurities affects the normal mode spectrum of the host lattice and also creates a localized vibrational mode of the lattice which lies above the frequency of the highest optical normal mode. In addition, the first electronic transition of the substitutional ion accounts for a broad absorption band in the uv spectral region (R. S. Singh, et al., "U Band in Cesium Halides," J. Chem. Phys., in press, June 1972). Upon replacement of hydrogen by deuterium, an isotope shift is observed for the spectral position of both the local vibrational mode and the first electronic transition. In addition, an isotope effect in the electron-phonon coupling is seen which manifests itself in the narrowing of the uv absorption band. Several theoretical models to account for this behavior have been constructed; our data support the model based on the shrinkage of lattice in the vicinity of the center. The basic model of the U center employed in the isotope shift analysis of the U band consists of a structure analogous to the F-center, e.g., a trapped electron to which a neutral atomic hydrogen or its isotope deuterium is added.

CLIMATOLOGICAL RELATIONSHIPS AMONG MOISTURE VARIABLES AT SELECTED STATIONS

Dorathy Anne Stewart
Physical Sciences Directorate
U. S. Army Missile Command
Redstone Arsenal, Alabama

Mean temperature, dew point, relative humidity, and vapor pressure are not related to each other in the same way that the individual observations are related. Two of the individual quantities determine the other two, but this is not true for means and other statistics.

When considering propagation through the atmosphere, one needs to know the mass of the moisture in the path of the radiation. The vapor pressure can be readily converted to absolute humidity, but unfortunately climatological data on this quantity are not normally available. Examples of calculations are discussed to illustrate that the errors resulting from attempting to infer climatological statistics for vapor pressure from readily available data are not negligible.

INTEGRAL NEUTRON SCATTERING MEASUREMENTS.

Arthur H. Werkheiser
U. S. Army Missile Command
Redstone Arsenal, Alabama

Neutrons from the reaction $T(d,n)^4\text{He}$ were scattered from carbon and aluminum. By detecting the recoiling alpha particles in the associated particle method, a 3° beam of 14.7-MeV neutrons was selected for the scattering studies. Using time-of-flight techniques, the flux and energy of the scattered neutrons were measured for several lab angles. A MONTE CARLO type computer program, CAVEAT, was used to predict the flux and energy of scattered neutrons also. Small scatterers were used to test the accuracy of the input cross sections. Also used were larger scatterers of more than one mean-path in size, to check the multiple scattering capabilities of the computer program. Some discrepancies were noted.

INDUSTRY AND ECONOMICS

DO CONSUMERS KNOW ANYTHING?

E. H. Bonfield
Department of Marketing
University of Alabama, University

A survey of 76 adults was conducted to determine whether those who guessed at correct answers to multiple-choice consumer-knowledge questions guessed correctly at a better than chance rate. Among consumers guessing answers, the correct answer was selected at better than the chance rate for 88% of the questions. Latent learning is offered as an explanation for this ability to guess correctly.

PROFILE OF THE UN- AND UNDER-EMPLOYED PROFESSIONALS:
A PRELIMINARY STUDY OF THE HUNTSVILLE
AEROSPACE EXPERIENCE

Ralph M. Cloud
University of Alabama, Huntsville

This preliminary study was made to ascertain whether there is a real problem of economic loss occurring in the Huntsville community due to shifts in national level policy decisions concerning space exploration and what the average effects of such budget re-allocations might be upon the labor market for the professional-technical personnel who were released. The indication was that indeed there may be no less than 1,400 once well paid workers still living in the Huntsville Standard Metropolitan Statistical Area from the approximately 10,000 total ex-aerospace types. Further, the indication was that these 1,400 ex-employees were generating an average amount per year of some three and one-third million tax dollars. This was a first approximation based upon incomplete data

Abstracts

which needs further and exacting study to affirm by in-depth surveys what the true extent and scope of this erosion of talent and income and tax producing ability for the Huntsville SMSA, the state, and the region actually amounts to for a year. Policy implications for longer range decision-making would thereby become better focused.

Records of a non-profit organization, called Alpha Institute, which is comprised of former professionally-technically employed members of several of the national level firms with branch plants and offices in Huntsville, were the sources for some of the material. Additionally, federal and state offices with employment data were used.

THE DECISION MAKING PROCESS IN THE JAPANESE MANAGEMENT SYSTEM

U. Wayne Dansby
School of Business & Commerce
Troy State University, Troy, Alabama

The past few years have produced an impressive list of developments within the economic and business sector of Japan. Among the most widely publicized of the recent developments have been "Expo '70 Super Show in Japan," and Japan's spectacular economic growth achievements.

In 1950, during my first trip to Japan, the GNP was approaching the 10 billion dollar mark, and in mid-fiscal year 1972, when I was departing Japan after my fifth trip the GNP was approaching the 250 billion dollar mark, an increase of about 25 times the 1950 figure. The London Economist has referred to Japan as the "Miracle State." Edwin O. Reischauer, the past Ambassador to Japan, says Japan is by far the major economic power in Asia. Herman Kahn, Director of the Hudson Institute, says "It seems quite plausible that Japan will pass the United States in Gross National Product (GNP) per capita by the year 2000 and possibly pass the United States in total GNP." James C. Abegglen, Vice President, Boston Consulting Group, forecasts, "The Japanese economy by 1974-75 will total some 400 billion dollars gross national product. That will be about the size of the present economies of the United Kingdom, France, Germany and Italy combined. It will give the Japanese per capita output roughly the order of latitude of the present United States per capita output order of magnitude....and the challenge for the United States at least is to understand what the Japanese are doing and try to apply whatever lessons we can from their enormous success to the management of our own economies and our own business."

In 1936, Japan was the world leader in the mass-production of bicycles, and in 1956 Japan was and continues to be the world leader in mass-production of ships as well as countless intricate and sophisticated products. The life expectation of men and women in Japan has risen to over twelve years from what it was in 1950 and personal income has advanced more than fourfold.

These are only a few of the hundreds of accomplishments by the Japanese people during the postwar recovery and the magnitude of achievements as a whole can be termed as spectacular, if not the greatest economic accomplishments in the shortest period of time ever achieved in the history of the world.

The role of decision-making has preceded all actions of the Japanese

economic achievements and behind all these actions countless decisions were necessary. This paper is to trace briefly the dynamics that lie behind the "Decision Making Process in the Japanese Management System."

AN ANALYSIS OF THE ECONOMIC SIGNIFICANCE OF CONCENTRATION
IN THE REGULATED INTERCITY TRUCKING INDUSTRY

Grant Davis
Auburn University, Auburn, Alabama

The regulated intercity industry is rapidly becoming highly concentrated. Although the industry is composed of numerous firms, a small percentage of the total number of firms controls an inordinate proportion of both output and revenues. This study used two techniques for measuring the extent of concentration in the industry, namely a Lorenz Curve and the Gini Coefficient. Both measures indicate that the industry is becoming more concentrated each year. This increase in concentration raises significant public policy questions. The paper ends by demonstrating that our current concept of "common carriage" is endangered by concentration inasmuch as the regulated trucking industry is exempt from the purview of the several federal antitrust statutes.

A STUDY OF STUDENTS' ATTITUDES AT THE UNIVERSITY OF
ALABAMA IN TUSCALOOSA CONCERNING LIFE INSURANCE

John Davis
Auburn University, Auburn, Alabama

The purpose of the study is to determine the attitudes of students at the University of Alabama in Tuscaloosa concerning life insurance. The hypothesis to be tested is that there is no relationship between students' sex, age, marital status, whether he has children, his parents' income and educational level, and his attitudes concerning life insurance.

An analysis of students' attitudes concerning life insurance was performed using statistical techniques applied to data gathered by telephone interviews from a random sample of the student body of the University of Alabama in Tuscaloosa in the Fall Semester of 1971. The objectives of the study are to determine factual and attitudinal information about life insurance ownership, the life insurance product, and the life insurers and their agents.

The study revealed significant relationships that existed between selected demographic data about the students and the students' attitudes concerning life insurance. In addition, the study analyzes noticeable trends that occur in the data.

The study should provide a better understanding of the college student life insurance market.

Abstracts

JUDGMENT IN MANAGERIAL DECISION MAKING: A PILOT STUDY USING ALABAMA EXECUTIVES

W. Jack Duncan
School of Business
Samford University, Birmingham, Alabama

This study attempts to examine several aspects of modern managerial decision making. Recently developed empirical evidence suggests that management decisions, especially those resulting in policy guidelines, are a complex mixture of fact and subjective values. In spite of this general recognition, there appears to be a tendency among writers on the subject to argue that managers, whenever possible, prefer not to acknowledge the existence of subjective judgement in ultimate decisions. In order to test some of these propositions and to accomplish a pretest for a larger study, a mail questionnaire was sent to 100 Alabama executive decision makers. A return percentage of 37 percent was obtained. Among other things, it was found that practicing decision makers included in this sample were quite willing to acknowledge the existence of personal judgment in over half the decisions made. In fact, they considered personal knowledge and experience and the knowledge and experience of co-workers as important as statistical-historical facts. The value of textbook references and original research was perceived to have significantly less value.

An additional finding of this study indicated that the majority of respondents did not feel that judgmental errors frequently resulted from the lack of objective information or in the interest of time. This contradicts much of the behavioral science findings which clearly indicate the impossibility of man to approach perfect rationality. Finally, the responding decision makers, although attaching a great deal of importance to computer information, did not desire additional information of this nature. The implication is that a point of diminishing returns has been reached.

SOCIALIST RENT THEORY AND AGRICULTURAL REFORM IN EASTERN EUROPE

Charles Michael Ellis
Department of Economics
University of Alabama, University

The Socialist theory of land rent has undergone considerable change in the last two decades. From a doctrinaire stance of Marxism, it has gradually taken on the appearance of Western socialist economic theory formulated earlier by Cassel, Beckwith, and Taylor. The current Soviet attitude towards land rent has been prompted by a concern for optimum land usage in order to maximize the national product rather than by a desire to remove inequalities in the distribution of income. Because Marxian theory regarded the payment of rent as strictly a capitalist phenomenon deriving from class conflicts, early agricultural planning in Eastern Europe did not include rent in the pricing of agricultural commodities or in the pricing of land. Because the state was theoretically the sole owner of land, rent payments for the use of land were

considered politically objectionable and economically unnecessary.

However, a concern for intensive economic growth and more efficient use of natural resources led a number of Soviet economists to explore the possibility of incorporating rent as an accounting cost in computerized simulation models of optimum land usage. Their simulations demonstrated the beneficially allocative function of rent in the use of land, in the pricing of agricultural commodities, in greater efficiency in the use of land, and in higher labor productivity.

Today, the socialist theory of land rent is almost unanimous in its denial of the validity of Marxian rent theory. Marxian theory, it was found, does not lend itself to optimal planning programs and, in this respect, is lacking in theoretical guidance for socialist nations attempting to improve their rate of economic growth.

Because the East European economies had incorporated Marxian rent theory into their agricultural programs after World War II, they were to experience difficulties with the theory when it was implemented on a large scale throughout that region.

EXPECTATIONS: KEYNES VS PIGOU

Patricia J. Evans and E. D. Chastain
Economics Department
Auburn University, Auburn, Alabama

The analysis of expectations is generally recognized as a major contribution of J. M. Keynes in his great classic *The General Theory of Employment, Interest and Money*. Professor Pigou proved to be the chief target of Keynes since he considered that Pigou made "the only attempt with which I am acquainted to write down the classical theory of unemployment precisely."

Examination of the literature disclosed that Pigou also discussed the role of expectations and contrast of the Keynesian and Pigouvian approaches to expectations. Among the results were identification of the lack of originality by Keynes and the importance of the concept in the work of both economists.

ANALYSIS AND EVALUATION OF PERSONNEL PRACTICES IN ALABAMA HOSPITALS

William H. Holley, Jr.
Auburn University, Auburn, Alabama

If personnel practices used by many private companies contribute to more effective manpower utilization, thereby contributing to better returns for labor expenditures, a logical question is: Are personnel practices in Alabama hospitals consistent with recommended practices? In this study selected functional areas of personnel management were analyzed and evaluated, and the results show that smaller hospitals and hospitals without personnel directors need much change and assistance in correcting functional areas of personnel management that have been neglected in the past.

Abstracts

Selection procedures, use of job evaluation, appeal systems, suggestion programs, morale surveys, performance appraisal, supervisory training, and auditing procedures of the personnel process are the functional areas where improvement is essential if more effective utilization can be achieved.

Recommendations not only include updating these areas, but practical approaches for implementation are presented. These include continuing education for administrators, sharing personnel directors, releasing managerial time for personnel administration, utilizing outside expert assistance, and employing a personnel director where feasible.

PREDICTIONS FOR THE RETAIL STRUCTURE OF GREAT BRITAIN DURING THE 1970'S AND BEYOND

M. L. Mayer
University of Alabama, University

According to leading marketing authorities one of the major changes within the retail structure of the United States during the 1970's and beyond will be the growing polarity of retail trade. This phenomenon can be described as follows. At one end of a continuum are mass merchandise outlets represented by the discount department store with food, or superstore, which is predicted to be the dominant convenience goods outlet serving the American consumer. At this same polar extreme is the high-volume, rationalized, supermarket-oriented, free-standing specialty store with a clarity of total offer. At the other extreme of the continuum is the regional shopping center which will be the dominant shopping goods complex for the 1970's; the new big tent in retailing, replacing the historically significant big tents of the past — the conventional department store, the central business district, and the community shopping center. The concurrent development at this same extreme is the boutique operation which is a highly rationalized, high yield, disciplined, and sophisticated specialty goods outlet. The hypothesis of the students of the retail structure is that these institutions representing the polarity of retail trade will provide the high yield and productivity necessary to attract investment in the future while the conventional outlets will be considered low yield and consequently will not by the outlets for new investment.

The retail structure of Great Britain is similar to that of the U.S. The polarity framework is useful to predict the changes within British retailing. For many years the United Kingdom looked to the United States for direction, inspiration, and leadership in many areas of human endeavor. Since the recent acceptance of Britain into the European Economic Community, there is little doubt that the new focus for businessmen in general will be their partners in the EEC who are perceived as being leaders in particular activities. Thus, while one may utilize an American framework for analysis of a similar structure, for prediction it is essential to look more carefully at continental Europe, particularly Western Germany, France, and Sweden where dramatic institutional developments are taking place. Many would conclude that European developments are more advanced and progressive than those in the U.S. at the present time.

Britain has been described as a nation of small shopkeepers. The casual observer immediately verifies this fact. The commitment to the

"high street" as the center of retail activity is apparent throughout the nation and is serving as a dramatic deterrent to the development of "out-of-town" shopping centers as well as the super stores, both of which are so significant in the U.S. and predicted to become even more important, and which are growing at rapid rates on the continent. In predicting the future development within Great Britain there is conflicting evidence, but the strongest evidence supports the prediction that even though there will be a significant institutional development lag in the U.K., the market itself, i.e. the consumer, will insist that the built in rigidities to structural change be relaxed. In addition there are enough management teams in Britain at present to force change in response to the socio-economic factors which are working in favor of the newer outlets and complexes. Just as the supermarket was a product of the 1950's in Britain (while in the U.S. this institution grew during the 1930's forward), it is predicted that the growing polarity in the retail trade will come at a later time and perhaps in a somewhat different form; but the structure will behave in essentially the same manner as it is behaving in the U.S. and the predicted changes will occur in Britain.

APPLICATION OF A DYNAMIC SIMULATION MODEL TO SOCIOECONOMIC
IMPACT ANALYSIS: A CASE STUDY

Carl C. Moore
University of South Alabama, Mobile

In recent years, simulation of economic systems through mathematical models has gained widespread acceptance as a research tool. The purpose of this paper is to examine the application of a specific simulation model to an actual case of negative economic impact.

The basic approach in using the model simulation technique for impact analysis is to first simulate the current conditions of the area and then project these conditions over the forecast period. Next, changes in the economic variables caused by the impact are fed into the model and projected. Comparison and analysis of the simulation runs provide a measure of the impact.

The closing of Brookely Air Force Base in Mobile, Alabama provided the basic information for the case study. During the 1967-69 period the Mobile SMSA lost approximately 12,500 civilian jobs due to closure of the base. The model is used to measure the initial loss in population, labor force, and employment and then project the effect of closure through 1980.

Finally, the simulation model technique as applied to impact analysis is evaluated through an examination of the advantages and disadvantages of the method.

A CLOSER LOOK AT KEYNES

Dorothy N. Sherling and E. D. Chastain
Economics Department
Auburn University, Auburn, Alabama

The term "Keynesian Economics" has become a part of standard economic

Abstracts

vocabulary in the past three decades. This paper represented an effort to study in depth the person for whom the "new" economics was named—John Maynard Keynes. This man of many talents, the ideas he presented, the characteristics which predominated his particular life-style, the period in which he wrote and taught, and the effect some predecessors had on his thinking were examined.

The second part of the paper reviewed and analyzed a number of the specific criticisms of Keynesian economics—both past and present. The final section was directed toward the relevance of Keynes' theories for economic policies in contemporary life. Some possible adaptations in macroeconomic theory with more variables incorporated into the model were noted. The ever-changing Keynes, were he alive today, would perhaps be modifying and extending his theory to include these variables to fit the needs of our ever-changing world.

CONFLICTS BETWEEN STATE PROTECTIVE LEGISLATION FOR WOMEN AND THE EQUAL EMPLOYMENT OPPORTUNITY PROVISIONS OF THE 1964 CIVIL RIGHTS ACT

Allan D. Spritzer
Management and Industrial Relations
University of Alabama, University

Title VII of the 1964 federal Civil Rights Act and similar state anti-discrimination legislation make it unlawful for employers to discriminate on the basis of sex in their hiring and employment policies, unless sex is a "bona fide occupational qualification" reasonably necessary for the normal operation of a business. In contrast, virtually all states have historically enacted special "protective legislation" designed to regulate or restrict employment conditions for women, but not for men.

This paper is concerned with the question of whether state protective laws for women continue to be valid in the light of more recent antidiscrimination legislation where the state laws have a discriminatory effect upon the employment of women.

The study examines the historical background of the constitutionality of state protective laws, such as those regulating maximum hours of work, occupational prohibitions and certain employment restrictions applicable to females. An analysis of recent case developments under Title VII of the 1964 Civil Rights Act suggests that state laws which adversely affect the employment opportunities of women are no longer valid for those employers subject to the federal anti-discrimination statute, because of the pre-emptive power of Title VII under the Supremacy Clause of the U.S. Constitution. This means that employers may not use discriminatory state protective laws as a defense to charges filed against them under Title VII. What appears to be less certain, at the present time, is whether the state protective laws are themselves invalid and unconstitutional under the Equal Protection Clause of the Fourteenth Amendment.

The best means of resolving the inherent conflict between the two categories of labor laws will be for the states to amend or repeal their protective legislation in order to bring them into compliance with anti-discrimination policies. The paper reviews some efforts that have been made to promote and to resist this objective.

SCIENCE EDUCATION

THE EFFECTS OF USING A SYSTEMS APPROACH TO SCIENCE INSTRUCTION ON ATTITUDE AMONG INTEGRATED ELEMENTARY SCHOOL STUDENTS

Neil P. Clark and Floretta G. Clark
Columbus College and Clubview School
Columbus, Georgia

The public schools of Muscogee County, Georgia were integrated in the fall of 1971 on a 70% white, 30% black racial ratio. Prior studies using this systems approach involved only white elementary students. This study involved an integrated class at Clubview Elementary School, Columbus, Georgia.

One purpose of this study was to compare the attitudes of students in the integrated class toward use of the Program with attitudes of two classes previously studied. The same attitudinal questionnaire was administered to all three classes. A second purpose of the study was to determine if students who had been identified as having reading difficulties would be more highly motivated to read as evidenced by increased interest in and use of books.

Analysis of the attitudinal questionnaire indicated that this group of students was at least as enthusiastic as the two classes studied previously. Only one student of 27 expressed negative feelings.

Teacher's observations of motivational effects in reading were that students with reading difficulties tended to select and attempt to read books on their own more frequently than has been observed in the past.

Conclusion of the study was that continued experimental use of this program is justified.

TEACHING THE GENETICS LABORATORY BY THE CONTRACT METHOD

Richard Couch
Biology Department
Athens College, Athens, Alabama

The desire for including more flexibility and individuality into my genetics course led me to adapt a relatively new teaching concept, the "contract method," to the laboratory portion of the course during the fall semester, 1971. Experiments were chosen to give each student in the class the experiences basic to an understanding of college-level genetics. Published laboratory books in genetics, genetics texts, and my own experience were the basis for decisions in choosing experiments, along with consideration of the present limitations of equipment, facilities, supplies, and personnel at Athens College. The realization that students have varying abilities, desires, and initiative was another factor in the original planning. Therefore, the basic experiences (experiments) as established by the above reasoning constituted what I termed the "required clauses."

Every student had to complete all experiments declared under the

Abstracts

required clause section of the contract. When a required clause experiment was completed, the student was encouraged to hand it in even though the declared deadline date might be some days in the future. The experiment had to be carefully and accurately written, following commonly accepted scientific style of writing. The American Institute of Biological Science publication entitled "Style Manual for Biological Journals" was the students' reference and guide for writing their reports. The experiments were graded as quickly as possible after they were turned in. Each experiment received either a grade of "S" (satisfactory), which entitled the student to full credit for that particular experiment, or a grade of "U" (unsatisfactory) which required the student to repeat the experiment, or rewrite the paper to conform to proper scientific style. Once the repeated work was completed, the paper could then be turned in again for consideration. As soon as the paper met the required standard, the student was given a "satisfactory" mark and received full credit for that particular experiment. Depending upon the length of time, difficulty, etc. of completing an experiment, 5 to 15 points were awarded for a satisfactorily completed grade and a "U" grade was theoretically the average, or the "C" grade. However, for students with demonstrated higher ability the standard tended to creep upward into the "B" grade level.

Satisfactory completion of ALL the "required clauses" secured 75 points in genetics laboratory, which counted toward a student's total grade for the course. These 75 points (out of a possible 100, or 75%) were sufficient for a letter grade of "C" from the laboratory portion of the course; this was combined with lecture grade to determine the student's final course grade.

If the student was not satisfied with a "C" for a laboratory grade, the contract provided a large number of "optional clause" experiments from which the student could choose. With the "satisfactory" completion of optional clause experiments, the student could make a laboratory grade of his choosing. In fact, if the industrious student satisfactorily completed more than 25 points worth of optional clause experiments, the points above the 25 required for a perfect 100 score in laboratory were added to his lecture grade. This practice might have to be changed in the future, but it has caused no problem so far.

Perhaps as a reflection on the initiative of students, or on my ability as a teacher to inspire students to higher achievement, two of the nine students in this small class chose not to do any optional clause experiments. This was their right as individuals even though I had hoped that all the students would do at least a few optional clause experiments. The same two students did not complete all the required clause experiments either, however. One of these students received an "F" for the course while the other received an "I" which gave him the opportunity to complete his laboratory work the next semester. This, combined with his good lecture grade, would allow him to pass the course.

One student made a perfect 100 points for genetics laboratory and four others made 90 points or better. Thus, five of the nine students in the class achieved in the "A" range, which indicates that, given the opportunity, most students will take the initiative to make the grade that they prefer; for most students the desired grade will be an "A."

I believe individuality and flexibility to be desirable features to incorporate into any course, since we are still teaching individuals even when class size may number into the hundreds. My first experience with

the contract method of teaching a portion of a college course convinced me of its value. I intend to continue using it for teaching genetics laboratory and to expand its use to other appropriate courses as time and energy permit.

PREPARATION OF JUNIOR HIGH SCHOOL SCIENCE TEACHERS

Judith C. Damewood
Auburn University, Auburn, Alabama

Many junior high school science teachers are inadequately prepared to teach meaningful science either because they lack a foundation in science or because they have little understanding of the young adolescent.

The program described has as its goal the preparation of teachers specifically for junior high school science. The program is built upon the assumption that the concepts and methodology learned in college science courses must be related in a concrete manner to what the student will actually teach in the public schools.

In order to achieve this integration it is proposed that the various science departments offer special inquiry-type courses for science education majors. Course materials would include regular college texts, junior high school texts, and other materials. Part of the course would consist of the students planning and executing the presentation of certain concepts to junior high school students. This planning would be done in cooperation with the university science instructor, the university science education instructor, and the junior high school science teachers. Seminars and laboratory courses in which students could prepare demonstrations and construct laboratory apparatus from inexpensive materials would also be offered by the science departments.

The Physics Department at Auburn University has demonstrated considerable interest in teacher preparation, and it is with the cooperation of this department that a beginning in the program described will be made in the fall.

ENVIRONMENTAL SURVEYS AS A TOOL FOR TEACHING ECOLOGY

Mary Nell Gonce
Bradshaw High School
Florence, Alabama

Highly concerned about what is happening to the earth and their immediate surroundings, many high school students ask questions about local ecology. In order to encourage the study of ecology the students in the honors biochemistry class ran an environmental survey in the areas of air, water, noise, and radiation pollution. The class was divided into teams with a chairman and secretary. The teams worked independently of each other with minimum faculty supervision.

The students themselves stated that the most important things they learned in this project were patience in collecting data and tolerance of others working in similar areas. As a result of the survey, most

Abstracts

participating students are now critical of any ecological data and begin at once to challenge its validity.

The project was successful in teaching research technique and team work, stimulating interest in the local environmental problems, and acquainting the student with the wealth of resources in our area.

BIOLOGY TEACHING IN THE SOUTHEAST: A STATUS REPORT

Carl R. Knotts
Georgia Southwestern College
Americus, Georgia

During the spring of 1971 a survey of the academic and professional training of biology teachers in 19 school systems of five southern states was conducted. Personal visits and interviews were held with 51 teachers. This report describes their current status.

Only 49% of biology teachers teach a full load of biology. Fifty-one percent held at least a bachelor's degree in biology. The typical biology teacher has earned a concentration in zoology; 7% had over 30 hours in botany while 35% had earned over 30 hours in zoology. A minority of 29% belonged to a professional organization and only 45% indicated that they read professional journals in science. A master's degree was held by 28% of the teachers.

Teacher suggestions for improvement in their work included: additional coursework, in-service activities, summer workshops, summer institutes, and laboratory oriented courses. Major recommendations from the study included: (1) cooperative planning between academic and professional education departments to insure a well balanced program for biology majors; (2) cooperative and up-dated planning of teacher certification requirements by certification agencies; (3) provision of a well balanced teaching methods course, which emphasizes laboratory or inquiry teaching; (4) leadership by local school administrators for in-service programs to local teachers; and (5) initiative on the part of individual teachers to seek additional academic and professional training to improve their teaching practices.

Many teachers were handicapped by poor facilities and supplies. In some instances good facilities and equipment lay idle. In the final analysis, good teaching requires a teacher who believes in his subject and his students and who will expend the time and effort to acquire knowledge, skill and facilities to conduct a dynamic biology program.

A METHOD OF ORAL TESTING FOR NON-READERS IN SCIENCE

Elizabeth F. Martin
University of South Alabama, Mobile

One of the greatest problems in elementary and secondary education continues to be the inability of boys and girls to read on the grade level to which they are assigned. As a result, these students are not able to respond to the traditional written tests. It is theorized that non-readers do learn at least some of the basic concepts which are

developed through the use of such tools as experiments, demonstrations, films, and field trips. The primary purpose of this study is to devise a method or methods of oral testing whereby learning may be evaluated without the necessity of reading and writing.

Three groups of students have been involved in the study. All were classified as non-readers, that is, as reading below the assigned grade level. Two groups were eighth graders from two different schools; the third group was comprised of fifth grade students. In two of the three situations the teaching, as well as the testing, was done by Dr. Martin and senior students in teacher education from the University of South Alabama. At the end of the lessons, which covered about five days, each child was given a written and an oral test. The written test was administered by the traditional method. Each child was tested orally, using one-to-one correspondence, one child per teacher. The questions and answers were recorded on tape. The teachers were permitted to elicit responses and to offer reinforcement, but not to give answers. The children were permitted to draw pictures to help in explaining their answers.

The results of t-tests indicated significant differences in the scores on the written and oral tests in each situation. As expected, the non-reading students scored significantly higher on the oral test.

This is a part of a study funded by the University of South Alabama. Although it has been limited in scope to this point, results indicate that the method is worth pursuing. The study will be continued involving students on other levels. An effort will be made to increase the practicality of the method, so that it may be used more readily by a single teacher.

SCIENCE: SENSE-APPEAL

Dutchie S. Riggsby
Columbus College, Columbus, Georgia

Many of the innovative special-effects which are utilized in television and the cinema can be adopted by elementary teachers to vitalize the teaching of science. The hard-hitting techniques so often encountered in the mass media are designed to stimulate highly, rapidly, and briefly. Elementary science is a natural for such approaches because: (1) children are sensitive subjects, and (2) every sensory avenue is, or can be, involved in "sciencing."

A few minutes of one's time spent on any Saturday morning, in front of the television set, will reveal what that medium is doing with sense-appeal and the youthful audience. The use of techniques such as: multiple screen or "split-screen," chronocompression, reverse-sequence, stop-motion, kinestasis, and animation, can all be accomplished by an elementary teacher with little training, reasonable effort, and relatively inexpensive equipment.

The project which is presented here involves the work of the author in an effort to illustrate some of the multisensory techniques which may be used to capture interest and to teach both concepts and attitudes. While the actual visuals presented have been edited to function as illustrations of technique, all of the materials have been used in actual classroom situations with fifth and sixth grade students.

Abstracts

COMPRESSED SPEECH: A STUDY OF THE USE OF INFORMATION RATE VARIATION IN A UNIT IN GEOLOGY

Ernest D. Riggsby
Columbus College, Columbus, Georgia
and

Hugh D. Pharris
Muscogee County Schools, Columbus, Georgia

Through recent developments in instructional technology and engineering, it has become possible to utilize electronically compressed (and expanded) speech in teaching situations. Such information-rate-variation makes it possible to present up to twice the normal number of words per minute in the spoken mode. While the average lecturer speaks at approximately 130 to 150 words per minute, the "speech compressor" allows speaking tempo to be increased by any increment up to approximately double the speed at which the original speech was delivered.

In the study here reported, the researcher, using an Eltro Mark II Information Rate Changer, presented concepts from geology to both control groups and experimental groups. The control groups audited recorded concepts at normal speaking rate of approximately 135 words per minute. The experimental groups were presented recorded concepts which had been compressed by a factor of: 0.20, 0.25, and 0.30. No significant differences were obtained between any of the pairs of groups when tested upon achievement and cognitive retention. All recorded concepts were taped from the same speaker (lecturer).

No experiments were attempted with compression rates above 0.30 because listening-training is often required with subjects (auditors) at rates above that level. Screening auditions were used with every potential subject in the experiment to ascertain a "threshold of intoleration" for aurally presented compressed speech.

A compression rate of 0.20 means that a given number of words presented at a normal speaking rate have been temporally adjusted so that they may be audited in eighty percent (80%) of the time required for their original delivery. In all of the compressions, the frequency fidelity and tonal quality are strictly preserved. Only tempo is altered.

Time saved in speech compression modes of lecture presentation is at the disposal of the instructor.

TEACHER AWARENESS TOWARD THE IMPACT OF FAILURE UPON ELEMENTARY SCHOOL CHILDREN

Prakash C. Sharma and Susan Linder
University of South Alabama, Mobile

In a technological society such as in the United States, education is a necessity. The individual's education commences at the elementary school level and this not only forms the foundation upon which all further education is based, but also molds the child's attitude toward education for life. It is felt that a great lack of awareness exists about the importance of the role the elementary school teacher plays in insuring a child's acquisition of knowledge. The major objective of this

study is to measure the amount of awareness toward the effects of failure on children that is realized by elementary teachers.

The data were collected by the questionnaire method. The sample of the study consisted of all elementary school teachers teaching grades 1-5 within the city limits of Mobile, Alabama during the academic year 1970-71. The amount of teachers' awareness toward the effect of failure on children was used as a dependent variable. The independent variables included in the study were: (1) age of the teacher, (2) the number of years of teaching experience in elementary school, (3) the grade level taught by the teacher, (4) the number of students they had failed in their teaching career, and (5) the level or amount of education they had completed. The sample included 19 schools with a total population of 382 teachers. The rate of return questionnaire was 40%. However, some questionnaires were not fully completed and therefore invalid so that the actual sample involved in this study consisted of 129 teachers. The Likert Scale of attitude measurement was used to measure the teachers' awareness and correlation technique was employed to study the relationship of five independent variables with the dependent variables.

The significance of this study seems established. The effects of failure in school on elementary school children cannot be over-emphasized; neither can the integral part played by the elementary teacher in deciding to fail a child be ignored. This study points out the need for teachers to be made aware of their responsibility in deciding to fail a child. Several different variables seem to affect the amount of awareness a school teacher possesses toward the possible effects of failure on elementary school children, especially the number of years the teacher has taught in elementary school. Age, grade level taught by the teacher, and number of years of higher education attained by the teacher all seem to have an effect on the teacher's amount of awareness. The findings tend to indicate that the more aware a teacher is the fewer students she fails. This study is limited in its application since the sample is representative only of a Southern city. Further studies to investigate this problem may find different levels of awareness among teachers in other parts of the country. However, it is demonstrated that not all teachers are aware of the possible effects failure in school may have upon a child especially at the elementary level. This is a problem which ~~not~~ only should be studied further, but should also be investigated by and acted upon by educators.

SEEK-IT IMPLICATIONS FOR UNDER-ACHIEVERS

William B. Shell

Human Resources Development Center
Tuskegee Institute, Tuskegee, Alabama

If we are to reach our professed general education objectives of science for all students, it is imperative that we give more attention to the underachiever and/or to the slow learner. All too often we have bypassed these students, assuming that science was too difficult. And of course, this will continue to be true as long as we teach science as a sequence of verbal abstractions.

The under-achiever (usually living in a motivational vacuum) will seldom learn unless he is able to anticipate some degree of success.

Abstracts

Like all of us, the under-achiever must see relationships, and build mental models as he structures his thinking. Our main challenge is to slow down the process and avoid applying too much pressure; for by so doing, we create frustration in the student if he sees more than he can accomplish with reasonable effort. Within limits, a student should have the opportunity to choose how deep and how fast he should go. The structure of science is the same regardless of the speed or depth it is pursued.

SEEK-IT, an acronym for Self-directed Educational Experience KIT, is a learning model that provides a self-paced, self-directed learning experience for the student and is ideally suited for the under-achiever. It is behaviorally based and provides an opportunity for any student to achieve some degree of success. SEEK-IT centers around a single group of related ideas and provides the learner with a variety of activities, with much self-evaluation and geared to the maximum interest span of the student. It is written on different levels and has a pretest that affords the teacher a diagnostic tool to determine if the student knows enough about the topic of the SEEK-IT to be able to exempt it and go to other SEEK-ITS. The pretest also indicates to the teacher if the student is ready for a particular SEEK-IT.

There are many "things" on the market today that will greatly assist the teacher in teaching tasks, but no purchasable product yet exists that will make a "turned off" teacher care.

PHYSICAL SCIENCE FOR NON-SCIENCE STUDENTS

Charlotte R. Ward
Department of Physics
Auburn University, Auburn, Alabama

As science and technology and their effects permeate every area of life nearly everywhere on earth it becomes desirable and even necessary that every person have some understanding of the methods and concepts of science. Physical science courses at Auburn University are aimed at introducing nonscience students to these methods and concepts by examining the concepts from a historical perspective in terms of the needs-to-know out of which they grew, the experimental evidence for them, and their consequences for both science and society, and by using a "process approach" to laboratory work that emphasizes what scientists actually do and how they do it. The mathematics used is kept to a minimum; the students will never need to solve the problem of the thickness of concrete shielding around a nuclear reactor, but they will need to arrive at an intelligent solution of the problem of where, or if, the reactor should be built in the first place.

HUMAN ANATOMY AND PHYSIOLOGY BY THE CONTRACT SYSTEM

George Williams, Jr.
Biology Department
Athens College, Athens, Alabama

In the summer of 1971, the contract system was employed in a one-semester course in human anatomy and physiology. Five units were selected and students were given a numerical grade on each of the units. The course grade was an average of the five grades. No mid-terms nor final exams were given.

Emphasis was placed on laboratory experimentation, individual oral quizzes, written quizzes, use of audio-visual materials, freedom of choice in laboratory work and laboratory experiences as an individual, and as part of a group. The course included study of cells and histology, the skeletal system, the muscular system, the heart and circulatory system, and the digestive system.

Types of contracts varied from signing for a letter grade to contracts with optional clauses. Students seemed more at ease during the class and laboratory exercises than in the conventional lab-lecture method. The professor was able to know each student individually after oral quizzes were given. Without question, the contract system was preferred by the students over the lab-lecture method. All students had previously taken biology courses taught by traditional methods.

SOCIAL SCIENCES

THE SILENT MAJORITY: THE DYNAMICS OF INFORMAL POWER

Murray Adams and Frances French
Department of Sociology
Auburn University, Auburn, Alabama

The situation outlined in this paper delineates a power struggle which occurred recently in a small southern town. The events are presented as indicators of certain power relations, as exemplifying a power model and as an illustration of the formal influence of an informal group.

MAJOR INFLUENCES OF THREE NEW DEAL AGENCIES ON EDUCATION
IN THE UNITED STATES PRIOR TO 1944

Jacquelyn M. Diener
Auburn, Alabama

Civilian Conservation Corps, Works Progress Administration, and National Youth Administration were the three New Deal agencies that had the most influence on education prior to 1944. To promote a better understanding of these three agencies within their cultural context, the "Great Depression" was described briefly, as were the Federal Emergency Relief Administration, Public Works Administration, and Civil Works

Abstracts

Administration. These agencies preceded and helped determine the programs of Works Progress Administration and National Youth Administration. CCC, WPA, and NYA each had distinct influences on education. CCC provided an opportunity for young men to learn conservation and construction skills and pursue academic studies. WPA's main effect on education was the preservation of adults' skills and the subsequent effect this had in teaching other adults and children new skills and appreciations especially in reading, writing, vocational work, and the fine arts. NYA's major effects were the immeasurable improvements in the lives of individuals who were helped to stay in high school and college, and making it possible for others of all ability levels to attend, and resulting in the upgrading of high school curricula to meet the needs of individuals in changing times.

CULTURE SHOCK AND SOCIALIZATION AMONG TEACHERS IN BICULTURAL SETTINGS

Patrick Ferguson
Department of Secondary Education
University of Alabama, University

In moving from a well-known to an alien culture the familiar cues and patterns of behavior are either distorted or absent. This may lead to the condition described by Edward T. Hall as "culture shock" in which the individual becomes cognitively disoriented, misinterprets reality, or is unable to communicate with his usual effectiveness.

There is evidence that teachers moving into new cultural experiences for the first time experience some of the above symptoms. They also foster inaccurate and negative attitudes about the other culture and this restricts their effectiveness in teaching students who are not of the same cultural background.

Specifically, they experience difficulties in the areas delineated by Hall in *The Silent Language*. These include differences in temporality and territoriality conceptions, occupational orientation, conception of the learning process, and languaging.

The proposals for helping teachers to cope with cross-cultural interaction included that they: (1) learn the overt and covert nature of the new culture, (2) receive exposure on an expanding basis to intercultural experiences prior to their assignment, (3) be desocialized from their previously nationalistic orientation and be resocialized in accordance with the idea of creating within them an "anthropological perspective," (4) learn to deal with valuing in a relativistic rather than absolute sense, and (5) learn the language of the other culture in terms of its meaning.

THE MEANING OF RADICAL SOCIOLOGY FOR SOCIOLOGY

Chester W. Hartwig
Department of Sociology
Auburn University, Auburn, Alabama

The radical sociology movement of the past few years does significantly raise the issue of values in scientific work and specifically in the field of sociology. It is an old topic of concern to the sociologist but a persistent one. This probably indicates the sociologist has not satisfactorily resolved a basic issue in carrying on his scientific task. As social science and other developments have redefined the nature of man and have reinterpreted his experiences in light of a wider acquaintance with the variety of understandings men have possessed, a crisis of meaning has developed. Radical sociology is a part of this crisis. One way to cope with this crisis in sociology is to turn our attention to the problem of how valuations affect scientific and other behavior. With such efforts we in sociology may contribute to the resolution of the crisis of meaning not alone in sociology but in human affairs more generally.

JOSÉ DE EVIA AND HIS ACTIVITIES IN MOBILE, 1780-1784

Jack D. L. Holmes
University of Alabama, Birmingham

José de Evia may have been Spain's outstanding naval explorer of the Gulf of Mexico during the eighteenth century. Born in La Graña, in northwestern Spain in 1740, he came to New Orleans in 1771. During the "cold war" between Spain and England of the 1770's Evia's vigilance kept raiding British corsairs at a distance. When actual war was declared in 1779 Evia helped capture an English schooner near Lake Pontchartrain. He commanded the frigate *Volante* in the Spanish squadron which sailed from New Orleans in January, 1780. Unfortunately, while pursuing an English frigate near the mouth of Mobile Bay on February 10, Evia's ship and the English frigate both ran aground. Stormy weather prevented the rescue of the vessel, but its planking was used in making scaling ladders for the capture of Mobile. After Captain Elías Durnford surrendered Mobile to Gálvez's forces on March 12, 1780, Evia carried dispatches aboard the *San Pío* between Gálvez and the commander of the Spanish squadron in the Gulf. As three English ships sought to capture him, he boarded a small boat and landed near Perdido Bay, successfully finding his way through hostile Indian villages to Mobile. He commanded batteries on Mobile Point and Dauphin Island during the siege of Mobile. In 1784 he continued his reconnaissance of the entire Gulf coast from south Florida to Tampico, Mexico. His description of the Alabama and Mississippi coast line, together with his excellent maps and charts were avidly studied at the Spanish Naval Academies by pilots and mariners who welcomed Evia's diligence and accuracy.

Abstracts

COMPUTER AIDED CITY MANAGEMENT

James P. Ignizio
University of Alabama, Huntsville

The development and use of an economically derived computerized urban information and display system is discussed. The system is composed of several subsystems which, by utilizing such input data types as scholastic test scores, crime incidents, unemployment rates, and so forth, provide both a quick-look comparative visual display output and selectable statistical descriptions and analyses. Such a system aids one in making objective judgments as to the success of urban programs (such as the Model Cities programs), in the reduction of problem areas and/or achievement of program goals within a city. In addition, the system also provides a means for detecting trends within the city in sufficient time so as to take the necessary remedial action.

THE GERMAN WORKING CLASS MOVEMENT AND THE AUSTRO-PRUSSIAN WAR OF 1866

William H. Maehl
Department of History
Auburn University, Auburn, Alabama

Basically Bismarck's efforts to enlist working class support were ultimately successful. The Lassallean General Workers Association (ADAV), sympathized with his aim of consolidating Germany. Under J. B. Schweitzer, the ADAV concentrated its attacks not upon the nobility but the bourgeois opposition to Bismarck and backed the Prussian war effort in 1866. By contrast, the Federation of German Workers' Associations (VDAV), which was the heir of early nineteenth century Liberalism and was allied with bourgeois democratic elements, was bitterly anti-Prussian. The VDAV's leaders--Sonnemann, Bebel, and Liebknecht--regarded the Prussian "military monarchy" as the enemy of the workers.

Although neither ADAV nor VDAV was Marxist, the latter was influenced by the gross underestimation Marx and Engels made of Prussia's war capabilities. Because VDAV leaders disparaged them and regarded Bismarck as an unprincipled villain who for the sake of Prussian aggrandizement would not scruple to plunge Germany into civil war, they struck an essentially reactionary posture in 1866 and afterwards. They pretended to believe that Prussia's overthrow would entail the bourgeois democratic revolution, which was the VDAV's maximum aim. However, practically, the VDAV's advocacy of regular military and militia-type resistance to Prussia by the secondary states ranged the organization behind the status quo. The VDAV's whole wartime propaganda on behalf of the liberties and sovereignty of the lesser states was tantamount to endorsing *Kleinstaaterei*. By contrast, Schweitzer's ADAV thought the consolidation of Germany would serve the interests of both the nation and the working class.

Even after the Preliminaries of Nikolsburg (July 26, 1866) VDAV attitudes towards Bismarck's North German Confederation were wholly negative and sterile. Only in 1875 did the movement led by Bebel and

Liebknecht finally merge with the bulk of the Lassalleans on what was preponderantly their platform, which contemplated not the violent overthrow of the Bismarckian political creation but its gradual democratization.

FRAMING CONFEDERATION LAND POLICY: THE ROLE OF THE
MASSACHUSETTS DELEGATION

John R. McCreary
Department of History
Columbus College, Columbus, Georgia

Throughout the Continental Congress's various deliberations during the 1780's, one of the most persistent issues was the question of the western lands. They had to be brought under a system of administration which would provide both a method of land alienation and a mode of government. In formulating this first comprehensive program for the west, the Congressional delegation from Massachusetts played a decisive role. Desiring two things from the western lands--reduction of the national debt and stability in the territories--Massachusetts spokesmen pressed for incorporation of these two points in any land policy adopted by the Confederation government. They consistently strove toward the establishment of a federal domain and also for unrestricted cessions, so that the resultant holdings would be governable and merchantable. The Commonwealth's representatives acted out of guarded self-interest in emphasizing the establishment of a federal domain; hoping to reduce the national debt by these means, while concurrently insuring a reserve to sink part of her own state debts.

The western territory could not be tapped as a means of revenue, however, until stable Indian relations were achieved. On this point also, the Bay State's delegates solidly opted in favor of effective federal power. They uniformly opposed any attempts by various states unilaterally to formulate or execute Indian policy. Taking a negative view toward unrestricted frontier settlement, lest the Indians be aroused, they attempted to ameliorate clashes between Indians and settlers by using the federal power to police frontier areas against incursions onto Indian lands. They also supported a federal treaty which would hopefully extinguish claims held by the Indians to the northwest. Until the Indian questions were settled, the west would produce neither income nor stability.

Coincident with their aspirations for the west, the Massachusetts men resolutely supported the anti-slavery clause on the theory that preventing the Negro's presence would make the west more attractive to the New England settler. They pressed for educational and religious reservations to encourage purchase and settlement along the lines of the New England system, and they blocked most attempts by Southern delegations to institute a policy of random, indiscriminate purchase. In fact, they led the Congressional fight to enforce regularized surveys which finally resulted in the compromise Ordinance of 1785, and the preservation, in part, of the New England Township system in Federal land policy.

The Massachusetts delegation was in contact with the Reverend

Abstracts

Manasseh Culter, and warmly supported his case in Congress. Aware that to adhere to the strict provisions of the Ordinance of 1785 would prejudice any land sale for at least another year, they successfully pressed for revision of that Ordinance, and for the enactment of a territorial formula capable of ensuring constructive settlement. Culminating Confederation land policy, the Northwest Ordinance of 1787 represented at least a sizeable victory for the Massachusetts Congressional delegation. Assuring the first sizeable purchase, it accomplished the two objectives of the delegates; it made the western lands a sinking fund for the public debt, and it provided a plan of territorial government conducive to orderly settlement. It incorporated the best features of the New England township system with the potential to sell in volume sufficient to assist in liquidating the public debt.

THE DEVELOPMENT OF BLACK RELIGIOUS INSTITUTIONS DURING PRESIDENTIAL RECONSTRUCTION IN ALABAMA, 1865-1867

John B. Myers
Columbus College, Columbus, Georgia

Soon after the surrender of Confederate forces at Citronelle, Alabama in May 1865, approximately 439,000 former Alabama slaves secured their freedom. The transition from slavery to freedom entailed the introduction of freedmen to a free labor system as well as to the responsibility of economic self-sufficiency. In spite of certain restraints which were imposed by whites on the economic, political and legal status of freedmen during Presidential Reconstruction, emancipation provided blacks the opportunity to create and participate in their own separate religious institutions.

As slaves, blacks frequently attended the churches of their masters but emancipation and reconstruction had quite an impact on the black and white relationship within Alabama churches. The Protestant Episcopal Church and the Roman Catholic Church opposed separate black churches and consequently neither had much success in their efforts to attract free black members. The Methodist Episcopal Church, South in Alabama which had 207,000 black members in 1861 resolved that freedmen could organize separate churches but saw no necessity for such action. Although these concessions seemed generous, the white methodists maintained control of the church hierarchy. In spite of efforts to maintain black membership, the number of freedmen in the Methodist Episcopal Church, South declined to 78,000 by 1867. Part of the reduction was attributed to the efforts of the Methodist Episcopal Church, North which competed with its southern counterpart but which only had limited success with black membership.

The churches which attracted the largest number of black members were the African Methodist Episcopal Church, the African Methodist Episcopal Zion Church, and the Baptist Church. These organizations gained black support by encouraging the development of separate black institutions and thus recognized the right of black self-determination.

The rapid growth of separate black churches reflected the freedmen's propensity for religion as well as their interest in adjunct social

activity and in the development of black leadership. The black ministers emerged as leaders among the Alabama freedmen in social, economic and eventually political as well as associated religious affairs.

Reconstruction of the church was closely related to the total reconstruction problem in Alabama. Both northern and southern white denominations assumed an attitude of mutual distrust and intolerance. While the former slaves were willing to accept aid from both groups they were not convinced of the sincerity of either. Blacks emancipated themselves from white supervision by developing their own leadership, churches, and social atmosphere, accompanied by the right to govern their own institutions.

SENATOR HEFLIN AND THE PRESIDENTIAL CAMPAIGN OF 1928 IN ALABAMA

Hugh D. Reagan
History Department
Auburn University, Auburn, Alabama

In 1928 Alabama Democrats by the hundreds bolted the Democratic party because of the nomination of Governor Alfred E. Smith of New York. Smith's stand on prohibition and his Catholicism were major issues in the bolting movement. Anti-Smith Democrats, not only in Alabama but throughout the South, organized to prevent the election of Smith.

An undeterminable amount of aid was given to the anti-Smith forces when Alabama's senior senator, James Thomas Heflin, bolted his party and campaigned nationally and locally for the anti-Smith Democrats. His failure to support the Democratic nominee cost him re-election to the United States Senate in 1930.

MEASURING SOCIO-ECONOMIC PROGRESS

Robert E. Shannon
University of Alabama, Huntsville

The problems associated with choosing socio-economic indicators to measure the progress of urban programs such as the Model Cities Demonstration Program are discussed. It is proposed that there is no such thing as pure indicators, i.e. indicators which can measure directly and unequivocally, one and only one component of the quality of life. Thus, in order to even attempt to measure the quality of life, one must look simultaneously at a whole group of indicators. Such a family of indicators is proposed. Finally, it is argued that indicators of changes in attitudes of the residents are at least as important as indicators of physical and economic change.

Abstracts

ANALYSIS OF FAMILY DIVORCE RATES

Prakash C. Sharma
Department of Sociology
University of South Alabama, Mobile

The major objectives of this study are to: (1) analyze the changes in divorce rate for the United States during 1920-1969; (2) compare the divorce rates of the United States with other countries during 1960-1967; (3) discuss disruption by death and divorce during 1950-1960; (4) analyze regional variation in the divorce rates during 1960-1967; and (5) study the demographic correlates such as age of husband and wife, duration of marriage, marriage order, race, socioeconomic status, etc. with the family divorce rates. The main sources of the data were Vital and Health Statistics Series, population censuses, demographic yearbook, and research studies in the area of family divorce. The number of divorces and annulments granted in the United States increased from the post-World War II minimum of 368,000 in 1958 to 523,000 in 1967 (an increase of 42 percent). This was the second highest national total ever observed for the United States; the all time high was 610,000 in 1946. Provisional data for the year 1968 and 1969 indicate that the number has continued to increase. In 1950, 1960, and 1963 nearly one-third of all marriage disruption in the United States was the result of family divorce and the remainder due to the death of one spouse. Between 1950 and 1963, disruptions due to the death of the husband and wife increased more rapidly as compared to disruptions due to divorce. From 1960 to 1967, the U.S. divorce rate rose from 2.2 to 2.6. The rates were lower for the Northeast region and highest for the West. During the same period, all four regions showed an increase in divorce rates. The divorce rate for states included in the D.R.A. is negatively associated with median duration of marriage at decree. The place of residence of divorced persons indicates a greater concentration in urban than in rural areas. It was also found that the non-white population had high divorce rates but it was in the proportion of the separated that the differences were most marked between white and non-white persons. However, for the divorce population in rural areas the percent of non-white was lower than for the white residents.

CULTURE AND POLITICS: A COMPARATIVE ANALYSIS OF MAVERICKS AND CONFORMISTS IN THE UNITED STATES HOUSE OF REPRESENTATIVES 1836-1860

Johanna N. Shields
University of Alabama, Huntsville

The period between 1836 and 1860 was one of sweeping and fundamental changes in the economy, society, and culture of the United States. Congressmen from every section of the country made reference to the promise of the American dream in its shifting forms: Did they actually conceive of themselves as active participants in its making? How closely were they involved in the cultural debate about the future shape of their society? Mavericks and conformists in the United States Congress reacted

very differently to the cultural changes which were taking place about them. Mavericks were highly sensitive to the influence of non-political forces acting upon the political area; conformists tended to view politics as a self-contained working environment. Mavericks were also much more inclined to apply to the political environment the moral standards they applied to the rest of their lives; usually this morality was extremely personalized, often narrow, but in any case quite demanding. Conformists derived their political morality either from the political environment itself, or from the general ethical standards of their region of the country. Finally, mavericks and conformists differed in the total orientation of their political attitudes. Mavericks constructed for themselves an imagined universe with themselves at the center providing guidance to American society; this universe contained the political world, and its structure dictated the requirements for their political behavior. In other words, mavericks had very individualized concepts of what American society was becoming, and of what their roles should be in its shaping. Conformists acted not on this egocentric basis, but took their cues from the political environment. Maverick response to the influence of cultural change was much more direct and personal than that of the conformists who, if they perceived the importance of cultural change, did not see it as significant to their political careers.

SOCIAL CHANGE AND CONTINUITY: THE UNIVERSITY OF ALABAMA
CAMPUS IN THE DECADE OF THE SIXTIES

Caterina C. Sutley
Department of History
University of Alabama, University

In the decade of the 1960's the University of Alabama moved from a conservative student body dominated by social Greek societies to a relatively liberal and politically activist throng. The outstanding social changes in this decade came by two forces: First, the natural change of any fluid mass of people; and second, the outside forces, principally integration by court order and increased federal monies. The University found itself, with about a five-year cultural lag, a part of the national trend among college students being more democratized, more socially conscious, and definitely more verbal in controversy. Continuity stemmed from the slow pace involved in changing social behavior in any large number of people, and in the particular setting of southern traditionalism.

The degree of change and continuity was observed by the researcher nine of the ten years involved. Resources in printed matter were principally the *Crimson-White*, the President's Annual Report, and other campus publications. Questionnaires were circulated among over 200 students and former students. An additional 100 people were personally interviewed. Surveys sponsored under the School of Education and the direction of Dr. Edward Florey and Lee Van Celf provided the most current statistics on the 1969 and 1970 students.

Abstracts

PERSONALITY CHARACTERISTICS OF STUDENTS IN FAMILY COUNSELING: A PILOT STUDY

Henry E. White, Jr.
Samford University, Birmingham, Alabama

Theorists have suggested that personality traits influence occupational choice. Using this theoretical framework, it can be assumed that the personality traits of students entering person-centered vocations, such as counseling, would be different from those college students in general. This study was conducted to test this hypothesis. Personality scores of twelve male students enrolled in a family counseling course were compared to the scores of a larger normal sample of college males. Difference of means tests were computed for each of the sixteen personality factors measured and it was found that there were significant differences in eight of the personality traits between the two samples.

SOLID WASTE COLLECTION PROBLEMS

Richard M. Wyskida
Department of Industrial and Systems Engineering
University of Alabama, Huntsville

The collection of solid waste is one of the major problems confronting American cities, yet it receives little formal attention and virtually no imagination is applied in coping with these problems. The real purpose of solid waste collection is to prevent the creation of rat-infested neighborhoods and, simultaneously, to create a clean living environment. The collection of solid waste, like all other government services, should be accomplished with the greatest effectiveness and efficiency.

This paper identifies some of the problems one encounters when the solid waste collection situation is thoroughly analyzed, and attempts are made to improve upon present practices in a particular city.

MEDICAL SCIENCES

Jesse William Lazear

Emmett B. Carmichael
Medical Center
University of Alabama, Birmingham

Jesse William Lazear was born in Baltimore County, Maryland, May 2, 1866. He attended Trinity Hall Academy, Washington, Pennsylvania, 1880-1884, and enrolled at Washington and Jefferson College in the same city in 1884. After two years, he transferred to Johns Hopkins University where he specialized in biology and chemistry. He received the B.A. degree in June 1889 and began the study of medicine at the College of

Medicine and Surgery, Columbia College, New York City, where he graduated with the M.D. degree June 8, 1892. Following training at Bellevue Hospital, he spent a year studying at Edinburgh, Paris, and Berlin. In 1897, he was appointed Assistant in Clinical Microscopy at the Johns Hopkins School of Medicine where he performed original studies in the malarial parasites.

On January 13, 1900, following the cessation of the Spanish-American War in Cuba, Dr. Lazear wrote to the Surgeon General of the Army requesting permission to join the Medical Service of the U.S. Army. He was accepted and reported to Quemados, Cuba, on February 11, 1900.

Because of the large number of deaths of servicemen due to yellow fever during the conflict and following the occupation of the island, Surgeon General George M. Sternberg induced the Secretary of War, Elihu Root, to appoint a Board of Army officers to investigate the cause of yellow fever. The Board consisted of Dr. Walter Reed, Chairman; Dr. Jesse W. Lazear; Dr. James Carroll; and Dr. Aristides Agramonte. Dr. Agramonte and Dr. Lazear were classmates at Columbia and received their M.D. degrees as members of a class of 116.

On September 13, 1900, while on visit to Las Animas Hospital, Dr. Lazear allowed an infected mosquito to feed on the back of his hand. Five days later, he came down with yellow fever and died on September 25. It was the first recorded fatal case where an individual allowed an infected mosquito to bite him; and as a result, he gave up his life in the pursuit of knowledge.

ENGINEERING

OPTIMAL FEEDBACK CONTROL OF WASTE WATER TREATMENT PROCESSES

J. Earl Bailey

Department of Aerospace Engineering, Mechanical Engineering,
and Engineering Mechanics
University of Alabama, University

Industrial waste water treatment plants are being constructed at an increasing rate to permit industry compliance with water pollution laws. The operating costs of these plants constitute a direct charge against a company's profits in most cases, thus providing motivation for development of integrated and automated treatment plant operation for minimum labor and chemical additive cost. In addition, good quality control of effluent is provided with controlled system operation. The aerobic biological waste treatment processes (activated sludge) studied here appear to be a major contender for treatment of many industrial wastes in the future.

This analytical study is an investigation of the dynamic response characteristics of automatically controlled and uncontrolled activated sludge plants. Optimal control theory has been used as an analysis tool for design of a plant feedback control system and for computing plant observability and controllability characteristics.

Continuous measurements, of the microbiological process state in the reactor, for control purposes are not possible with state of the art in-

Abstracts

strumentation, so observability characteristics of the plant are very important. Statistical control theory has been used to design filters which generate a continuous minimum variance estimate of the reactor kinetic process using measurements which are simple to implement.

The process mathematical model used in this analysis is an eleven variable model of the process hydraulics, reactor kinetics, and clarifier dynamics. The nonlinear system equations were linearized about a desirable steady state operating condition and the influent process statistics are approximated with a shaping filter.

ONBOARD ATTITUDE DETERMINATION OF A TUMBLING ASTEROID

John E. Cochran

Department of Aerospace Engineering
Auburn University, Auburn, Alabama

The Comet and Asteroid Rendezvous and Docking (CARD) mission concept proposed by the National Aeronautics and Space Administration is reviewed briefly. The additional complexity introduced into the problem of automatically landing an unmanned spacecraft on an asteroid by the asteroid's *a priori* unknown rotation about its mass center is discussed. The theoretical foundations of an algorithm for determining the rotational state of an asteroid from spacecraft acquired data are laid and the algorithm and modification thereof are presented. (This work was sponsored by NASA under contract NAS8-27664.)

A PRECISION VACUUM X-RAY REFLECTOMETER

Stanley A. Fields and John M. Reynolds
Space Sciences Laboratory
Marshall Space Flight Center, Alabama

The X-ray reflectometer is designed to measure, with an angular resolution of a few arc seconds, the surface of a 2.54-cm diameter optical flat. The instrument is used to measure the X-ray reflecting and scattering properties of selected materials as a function of the surface finish achieved with different polishing techniques. The reflectometer is a mechanically driven instrument that operates inside a vacuum environmental chamber at 1×10^{-4} to 1×10^{-7} N/m². The primary components of the system are: (a) X-ray source, (b) slits, (c) clinometers with crystal and sample fixtures, and (d) detectors.

ATMOSPHERIC HEATING OF METEORS

Kenneth E. Harwell, John T. Best, and T. Dwayne McCay
Department of Aerospace Engineering
Auburn University, Auburn, Alabama

A theoretical model of the radiating metallic gas produced about an

iron meteor entering the earth's atmosphere was discussed. Numerical results were presented for a 0.1 cm diameter iron meteor traveling at 15 km/sec at an altitude of 100 km above the earth. It was shown that collisions between the expanding iron gas and the air molecules produce a radiating gas shell a few meters thick located many meters ahead of the meteor core. Temperature, pressure, and density distributions were presented as functions of radial distance and angle for several initial meteor conditions. The numerical results indicate the following:

(1) Due to the high thermal conductivity of iron and the small physical size of the iron meteors studied, the temperature inside the meteor is essentially constant, with the maximum temperature difference between volume elements remaining at approximately 24°K until melting occurs. This indicates that, for engineering purposes, all portions of the solid meteor melt at essentially the same time.

(2) Since the energy addition due to the molecular beam interaction at the solid surface was quite high and the thermal conductivity was large, thermal radiation from the solid surface may be neglected for the small meteors studied. Thermal radiation had a negligible effect on the temperature distribution.

(3) Using an assumed exponential initial metallic gas density distribution, numerical results were obtained for a 0.1 cm diameter iron meteor traveling at 15 km/sec at an altitude of 100 km above the earth.

(4) The metallic gas temperature distribution was found to reach a "steady state" distribution in a short period of time. It was found that the major heating occurs in a thin gas shell a few meters thick, many meters ahead of the small meteor. The high temperature region created by the interaction thickens as time proceeds and then moves out away from the center of the meteor.

(5) Temperatures in the $5,000^{\circ}\text{K}$ to $10,000^{\circ}\text{K}$ range were calculated in the interaction region. Thus, it follows that the major visible radiation emitted by small meteors will occur from a gas shell of a few meters thick many meters ahead of the meteor center.

(6) The metallic gas-air molecular beam interaction was found to occur at the point where the metallic gas density was less than two orders of magnitude higher than the atmospheric density.

DEEP-WELL DISPOSAL OF LIQUID WASTES IN ALABAMA

Charles D. Haynes
College of Engineering
University of Alabama, University

A study concerning deep-well disposal of liquid wastes in Alabama has been undertaken by the Natural Resources Center at the University of Alabama and the Geological Survey of Alabama. The physical and chemical requirements for a successful deep-well disposal system, (i.e.), porosity, permeability, formation geometry, confining beds, and chemical compatibility of waste and native reservoir liquids were examined in the State of Alabama.

Geological considerations for deep-well disposal in Alabama were studied in three areas: Piedmont, Tennessee Valley-Warrior Basin, and Coastal Plain. Scarce subsurface information in the Piedmont prevents

Abstracts

a detailed analysis of deep-well disposal prospects, but they are generally considered to be poor in this area. The Tennessee Valley-Warrior Basin shows promise in the Knox dolomite, Cambrian sands, and basal Pottsville and Mississippian sequences. The Coastal Plain should provide the best area for deep-well disposal, since the geology is favorable and extensive subsurface information is available from petroleum operations.

Several deep-well disposal systems are operating in Alabama, and others are planned for the immediate future. Legal statutes concerning the operation of disposal wells, however, are lacking and are urgently needed.

COMPUTER GENERATED DIGITAL HOLOGRAPHY AND APPLICATIONS

Roy L. Heifner, Jr.

Recently, the digital computer has been used to produce quality holograms by calculating and plotting a set of complex values. It is the purpose of this presentation to explain how such holograms are made and outline some applications.

In computer-synthesized binary holography, the computer calculates the two-dimensional Fourier Transform of the image to be recorded, using the Fast Fourier Transform Algorithm. (The Fourier Transform is a complex function, having real and imaginary parts.) A two-dimensional plot of "apertures" is made from this calculated set of values. The locations of the apertures are arranged in such a way that they convey both the intensity and the phase of the transform of the object field. A photograph of this computer plot is made, and this photograph is the digital hologram. Upon illumination, a lens is used to "re-transform" the field or reconstruct the original field.

There are several techniques for placing of the apertures in such a way that they convey both intensity and phase information of the field to be recorded. One of the better techniques is that of Lohmann, which uses a variable height aperture with lateral displacement from a center point for each sample value calculated. The height of the aperture conveys intensity, and the displacement from a center point conveys phase information. It has been shown theoretically and experimentally that this technique produces holograms which are of quality comparable to those made with conventional interference techniques.

Computer generated holograms have found application as complex spatial filters in coherent optical data processing systems, where computer-synthesis techniques have been extended to the construction of filter transmittances which are not obtainable optically. One of the most promising applications of computer generated holography is that of testing optical surfaces, in which case the hologram is used to produce the reference wavefront.

LIQUID WASTE DISPOSAL IN DEEP SALINE AQUIFERS

H. R. Henry
Department of Civil and Mineral Engineering
University of Alabama, University
and
F. A. Kohout
U. S. Geological Survey, Washington, D.C.

In recent years considerable interest has been focused on deep saline aquifers as reservoirs for the disposal of liquid waste. In general, the water in such aquifers is already in motion controlled by 3 sets of gradients: The hydraulic-pressure gradient, the geothermal gradient, and the salt concentration gradient. In thick aquifers, interaction of these gradients induces gravity convection currents which are not present in constant-density fluid systems. The fate of the waste liquids entrained in this fluid system will depend (among other things) upon the state of motion in the aquifer before injection and the modification of this state by the injection process.

A hydraulic laboratory sand model was built to simulate a saline aquifer, a geothermal source, freshwater recharge, and waste-injection wells. The studies show stream lines, velocities, and temperature/salinity distributions before and during waste injection. The governing equations, namely the hydraulic flow equation, the diffusion equation for salt and injected contaminants, and the heat diffusion equation are solved simultaneously on a high-speed digital computer. Obtaining theoretical solutions comparable to the model data requires choosing correct empirical values of coefficients of salt and heat diffusion.

After the validity of solutions of the governing equations is established by comparison with the model studies, a basis for prediction is investigated by comparing theoretical solutions for field conditions with temperature and salinity data from selected oil exploratory wells in the Floridan aquifer of southern Florida. (Publication authorized by the Director, U. S. Geological Survey.)

A PARAMETRIC STUDY OF STABILITY OF CELL INACTIVATION
DUE TO REPEATED RADIATION EXPOSURES

C. K. Liu
Department of Mechanical Systems Engineering
University of Alabama, University

The stability of processes and conduct of physical or chemical systems has commanded the attention of scientists and engineers throughout the development of modern technology. Generally, a system or reaction is stable when external or inherent disturbances are damped and vanish with time; otherwise, a system is unstable. The causes and the manifestations of instability have been identified and are well understood in some cases. In others, neither causes nor manifestations have been adequately described. However, satisfactory criteria can be developed

Abstracts

from the results of experimental and theoretical stability investigations, even when the real reason accounting for the presence of unstable modes cannot be readily assessed.

The apparent similarities between annihilation of animal cells due to one or successive radiation exposures and chemical reactions, with primary and secondary phases, suggest that analytical techniques may exist that are commonly applicable, especially in the area of stability analysis.

This paper presents a basic quantitative parametric study wherein the stability of cell annihilation, (or cell survival) under the repeated assault of ionizing radiation is treated. A reasonable model of cell death or inactivation is developed that can possibly serve as a basis for increased understanding of this complex reactionary phenomenon.

EFFECTS OF BLAST PENETRATIONS ON MISSILE ATTITUDES AND TRAJECTORIES

Al Marrin and John E. Cochran
Department of Aerospace Engineering
Auburn University, Auburn, Alabama

Digital simulation of the dynamics of a missile penetrating a blast wave is discussed. The mathematical model for the simulation includes a three-degree of freedom dynamical model for the missile, flap-type control with inherent time lag, aerodynamic characteristics obtained from curve-fitted empirical data and a model of the blast environment constructed by Kaman Nuclear. Results for typical cases are also presented. (This work was sponsored by the U. S. Army Advanced Ballistic Missile Agency under contract DAHC60-71-C-0076.)

A STATISTICAL APPROACH TO OPTIMIZATION OF FILTER TUNING PROCEDURE

U. Parikh
Sperry Rand Corporation
Huntsville, Alabama
and
J. Kerr
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

This paper proposes a statistical approach to the development of an improved filter tuning procedure. The standard procedures in common use are based primarily on trial and error. Also, all filter elements and all tuning adjustments do not affect the final filter parameters equally. This statistical approach to optimization of filter tuning procedures utilizes the following techniques: (1) coefficient of correlation analysis and (2) regression analysis.

Both the coefficient of correlation analysis and regression analysis give a measure of the joint behavior between particular adjustments and selected final parameters. The adjustments on filter elements with highest measures of joint behavior relative to the critical final parameters

should be handled with precision, in order to achieve the most efficient tuning procedure. The computerized optimization algorithms make use of sample data taken during the tuning of a pilot set of filters. (Work performed under sponsorship of the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Contract NAS8-21812.)

WASTE GLASS AS A COMPONENT IN LIGHTWEIGHT AGGREGATE

Reynold Q. Shotts
Department of Civil and Mineral Engineering
University of Alabama, University

Under contract with the U. S. Bureau of Mines, the possibility for making lightweight aggregate from generally inferior materials, to which waste glass had been added, was investigated.

Two methods were investigated: (a) rotary kiln and (b) sintering. Primary materials used were shales, known to produce unsatisfactory aggregate when processed alone, coal washery refuse, and a coal underclay from a strip pit. Forms of waste glass used were incinerator refuse from Atlanta, Georgia (31% glass, 37% combustible); broken soft drink bottles; and processed glass (minus 20 mesh), U. S. Bureau of Mines pilot plant, College Park, Maryland. Some control tests were made using the primary materials alone. One of these was an excellently expanding shale presently being used to produce commercial lightweight aggregate.

Aggregates meeting ASTM loose pour unit weight specifications were produced in most of 34 kiln tests. Concretes made with glass-containing aggregates generally were slightly stronger in proportion to weight than those using commercial gravel aggregates or aggregates from primary materials alone. Batch sintered aggregates were more uniform than those from kiln tests. Mortar bar tests gave only slight evidence of potential deleterious expansion due to reaction between the alkali of the cement and glass.

It was concluded that full scale commercial test weights show that areas with poorly expanding aggregate materials and large supplies of waste glass might more economically meet heavy lightweight aggregate demands using local materials.

SYSTEM FUNCTION SENSITIVITY OF SINGLE COMPONENT ERRORS IN APPROXIMATION TYPE FILTERS

G. Weathers and J. Kerr
Sperry Rand Corporation
Huntsville, Alabama
and
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama

The application of passive approximation type filters for applications requiring stringent control of the filter parameters has been inhibited by the difficulty in turning these filters. The standard procedure, while adequate for most applications, has a disadvantage that

Abstracts

equal attention is given to each element in the filter circuit. However, for a particular filter parameter, all filter elements do not affect the parameter equally. A tuning procedure proposed as a result of this study allows the effort in adjusting a particular filter element to be in proportion to that element's effect on the critical parameter.

The procedure utilizes as the critical parameter the RMS value of the difference in the response functions of a filter and its theoretically perfect reference. This RMS difference is calculated as a function of the variation of each filter element from its synthesized value. Assuming that the RMS difference function is accepted as the critical parameter in filter design, then those elements whose variations most affected this parameter should receive proportionally more effort to assure their accuracy. (Work performed under sponsorship of the National Aeronautics and Space Administration, George C. Marshall Spaceflight Center, Contract NAS8-21812.)

ANTHROPOLOGY

GAINESVILLE SALVAGE 71; A REPORT ON THE FEATURES ENCOUNTERED AT THE TWO PRIMARY EXCAVATION SITES 1Gr1 AND 1Gr5

Bruce D. Bizzoco
University of Alabama, University

During the summer field season of 1971, the University of Alabama Museum in cooperation with the National Park Service conducted a program of salvage archaeology in the Gainesville Basin of the Tombigbee River. The project director was David L. DeJarnette and the field crew was under the supervision of Jerry Nielsen.

Site 1Gr1 yielded many pot sherds and pits, but the two main features were a sandstone bowl and a possible Big Sandy projectile point.

Site 1Gr5 yielded a large number of features. A total of 59 post holes were recorded, most of which contained a small amount of cultural material. Careful inspection revealed a semi-circle pattern, which further investigation may prove to be a structure.

AN ANALYSIS OF THE DENTAL MATERIAL FROM PINSON CAVE (1Je20), A PRELIMINARY REPORT

Ralph H. Bunn, Jr.
University of Alabama, University

The dental material recovered from Pinson Cave (1Ke20) has been selected for an in depth analysis. This site was excavated by the Department of Anthropology of the University of Alabama during the period of 1969-1970. Included in the dental material were 211 mandibular and maxillary fragments and approximately 972 loose teeth.

My research is limited to the study, description, and analysis of the dental material from this site. The purpose of this study is:

(1) to determine the total number of individuals deposited at this site; (2) to analyze dental disorders and, in general, the dental health of these people; (3) to determine the frequency of anthroposcopic features and their ethnic significance; and (4) to ascertain the racial affinity of the people interred in Pinson Cave.

COASTAL PEASANTS, VACATIONING URBANITES, AND FESTAL
HONORING OF THE VIRGIN IN YUCATAN

Joan N. Eich
University of Alabama, University

Yucatan shares with Mexico, and all Spanish America, the concept of a community patron saint. The community can be a village, a town, or a barrio or quarter of a town or city. The traditional ideal pattern was that each patron should be honored in an annual fiesta to thank the saint for past blessings and protection and to express the hope that relations between the patron and the people, the saint and the devotees would continue. Again, ideally, the fiesta should be elaborate, involving participants of most or all residents of a community and many visitors. Actually, most communities (for largely unstudied reasons) recognized the patron in only simple ceremonies of prayers carried out by a few, the very faithful. The more elaborate patron celebrations will concern us, as they do other investigators; for it is difficult to study a non-fiesta.

Each region, such as Yucatan, has its own distinctive festal complex, a variant of the national and Spanish American pattern. And within Yucatan, there are differences among fiestas. Each one that has persisted over many years develops some special characteristics. This paper concentrates on a particular fiesta, that of Chicxulub. It is a community on the Gulf Coast, 38 miles north of Merida, the capital of the State of Yucatan, a city of more than 200,000.

SIZE CHANGES IN CARBONIZED SEED FOODS

Eugene M. Futato
University of Alabama, University

In all but the very dry and very cold regions of the world, preserved archaeological botanical material is generally limited to carbonized specimens. The two carbonizing processes, oxidation and destructive distillation, also cause a change in the size of the preserved item.

The improvement of plant species through cultivation is generally reflected in an increase in overall size, thus an increase in seed size. This is particularly true if the seed or fruit is the utilized portion. Thus establishing the original size of carbonized seeds is an important element in tracing the progress of agricultural development.

Experiments with three varieties of *Phaseolus vulgaris* showed an increase in length of 3%-10% as a result of oxidation, and a decrease in length of 3%-5% after distillation. Similar experiments with three

Abstracts

varieties of *Zea mays* indicated a 6%-12% decrease in length after each process.

THE DAVID-GOLIATH CONTEST IN THE CONTEXT OF CULTURAL ECOLOGY

Asael T. Hansen
University of Alabama, University

The paper begins with a sketch of the Biblical version of the contest and its usual Sunday-School interpretation. The scene then shifts to the grassy uplands of the interior of Madagascar. Early in the present century, a converted native pastor delivered a sermon to his congregation of local converts, citing the David-Goliath episode to increase their faith in their new-found God. The account had undergone massive revision. God's miracle consisted of affecting the mind of Goliath, causing him to become so stupid that he went to certain death with his short-range sword matched against David's long-range missile. In central Madagascar the sling was a standard battle weapon, lethal in the hands of any adept and well-practiced man. For the Biblical rendering to make sense to people living in that cultural world and for it to remain a suitable faith-promoting parable, it had to be changed.

The sling is ecologically limited. The device can be effective only in open country where the vegetation does not interfere with the launching operation or with the flight of the object launched. Forests preclude its use.

At this point I focus on the question: Why did Goliath voluntarily enter such an unequal encounter? The Philistines, speakers of a non-Semitic language, are said to have arrived in Palestine in the 1200's B.C., about the time the Hittite Empire was rapidly falling apart. They might have been one of the refugee peoples, fleeing from the turmoil in the north. If so, their former homeland might have been forested or forested enough to prevent the development or adoption of the sling. Goliath and his fellow warriors might have been quite unaware of the weapon's lethal potential. Fighting men are notoriously conservative as regards military tactics and technology, often suffering disastrous defeats before accepting innovations.

A further problem is posed. Why does the Biblical version have the Lord helping David so much that the triumph over Goliath is really the Lord's? This was the component of the chronicle that seemed wholly incredible in Madagascar. Attention is called to the fact that the Bible itself indicates that the Israelites relied on the sling for purposes of practical survival; it is not referred to as a mere toy. I speculate that, perhaps in the oral tradition of the Hebrews during an era when the sling was truly a serious weapon, it figured in some heroic occurrence. Subsequent progress in weaponry rendered the gadget obsolete. The keepers and transmitters of the sacred lore, faced with growing inconsistencies, may have recast the recital, thus giving us the still-current Biblical account which glorifies both David and the Lord and discredits the sling.

I close by inviting ethnographers, archaeologists, ethno-historians, and historians to be ever-mindful of the importance of cultural ecology. The matters dealt with and speculated about may suggest possibilities for future theses and dissertations.

Journal of the Alabama Academy of Science

ANTHROPOLOGISTS ARE PEOPLE: THE FABULOUS CAREER OF
S. G. MORLEY

Mary Cassandra Hill
University of Alabama, University

Sylvanus Griswold Morley was born in Chester, Pennsylvania on June 7, 1883. Thus began the life of one of the world's greatest Mayanists.

Some of his greater accomplishments were: A.B. from Harvard (1907); M.A. from Harvard (1908); field worker for the School of American Archaeology (1909); research associate, Carnegie Institute (1915); associate (1918); U.S. Naval Intelligence Officer, W.W.I; director, Chichen Itza project, Yucatan (1924-1940); headed Calakmul expedition (1932); Loubat Prize, Columbia University (1943); honorary Ph.D., Pennsylvania Military College (1921); the Order of Quetzal of Guatemala (1939).

Most people know him for these accomplishments. However, the purpose of this paper is to show that Morley was just as "human" as the rest of us.

EXCAVATIONS IN A WINSTON COUNTY BLUFF SHELTER, 1972

Karen Joines
Samford University, Birmingham, Alabama

Fourteen 5-ft squares with 2-ft balks were sunk in January of 1972 in a 171-ft long bluff shelter facing eastward. The stratification was simple. There was normally about 2-3 inches of loose brown topsoil, followed by a dark brown, sometimes black, layer averaging some 30 inches in depth. This was superimposed on pinkish sand becoming yellow with depth. In addition, two 5 by 8-ft sections were cut in an opening in the shelter about 18 inches high, 10 ft wide and some 30 ft from its southern end. Some 120 identifiable projectile points were unearthed dating from the early archaic to the Mississippian period. Further, hundreds of bone fragments and potsherds were recorded. The most interesting and perplexing discovery was the remains of a partially disarticulated burial of an adult human on what at one time was a fire hearth.

Final conclusions have not been determined at this time. It appears that the shelter probably was used by small hunting parties from the early archaic period for the following 6,000-8,000 years. With a spring nearby, and with its extensive overhang and cave, the shelter was ideal for such usage. With a Carbon 14 dating of the bones and further classification and cataloging of the points and pottery in the various strata and depths, we should be able to form a more complete picture of the site's history.

Abstracts

THE ADJUSTMENTS OF KOREAN STUDENTS AND EX-STUDENTS TO THE USA: COMPARISONS AND CONTRASTS

Wonhee Lee
University of Alabama, University

I am a Korean student in the USA. The prime data for the paper come from my own experience. The advantage of this procedure is that I know most fully what happened to me and how I felt while it was happening. The danger, of course, is that my report may be purely subjective. I take the view that subjective learning can be given a considerable degree of objectivity by deliberately viewing it *as data*. In a sense I see myself as an instrument which recorded experiences ranging from pleasant and pleasurable to disturbing and even painful. A further step toward objectivity consists in conversing with other Korean students and matching their crossing of a major cultural boundary with mine.

The adjustments (and maladjustments) of ex-students present interesting similarities and differences. These can be learned about only through interviews (which I prefer to think of as conversations).

My technique is to present in detail a sequence of episodes. They are later accounted for and linked together to reveal the adjustment process and its results. The intention is to tell a vivid story as well as to report reality in such a way that it can be used for the purposes of social science.

KNOSSOS, THE UNPLUNDERED TREASURE OF CRETE

Helen M. Mabry
University of Alabama, University

Vandalism and theft are great problems in contemporary archaeology. The palace of Knossos in Crete is one of the rare Old World classical sites to escape wholesale plunder by archaeologists of other nations. Crete has been conquered and occupied by foreign peoples from the Graeco-Roman era to the twentieth century. Their land and people have been exploited by outsiders.

Native Cretans began collecting artifacts from their own past while it was necessary to get permission from Turkish authorities. Almost coincidental with independence from Turkey, Sir Arthur Evans uncovered the evidence of the great Minoan civilization. Today it is possible to study the history of Crete from Neolithic to Roman days without leaving the island.

EXCAVATIONS IN JERUSALEM OF THE JEWISH TEMPLE FROM THE ROMAN PERIOD

Carolyn Marx
Samford University, Birmingham, Alabama

The first portion of the paper deals with the historical background of the Jewish Temple, from the purchase of the land by David through the

Solomonic structure and its subsequent destruction by Nebuchadnezzar.

The Second Temple, built by Zerubbabel after the Persian exile, was the one dismantled and rebuilt by Herod. The middle section of the paper is a detailed description of this Temple complex based on the account of Flavius Josephus, the Jewish historian who defected to Rome during the Jewish War of A.D. 66.

The main body of the paper deals with the archaeological excavations of Benjamin Magar, begun in 1968 under the auspices of the Israel Exploration Society and Hebrew University's Archaeological Institute.

I-65 HIGHWAY SALVAGE, 1971: A PRELIMINARY REPORT

Carey B. Oakley
University of Alabama, University

During the spring and summer of 1971, the Anthropology Department, University of Alabama at Tuscaloosa, conducted an archaeological salvage program in portions of Elmore and Montgomery Counties. Specifically, these activities were concentrated in the immediate area of future Interstate 65 north of Montgomery, Alabama.

Thirteen archaeological sites were located which would be affected by the construction of this highway. Two of these sites, 1Ee 101 and 1Mt 86, were extensively excavated. The remaining eleven sites received varying amounts of test pitting depending on their apparent archaeological significance. Tentative examination of materials recovered from these excavations indicate that the areas investigated represent an aboriginal occupation extending from Middle Archaic through Late Woodland times.

PAST AND PRESENT VIA INDIAN SKELETON

Donald Lee Osborne
Athens College, Athens, Alabama

On Saturday, January 2, 1971, at the noon hour, the remains of an Indian skeleton were discovered. These fragments of bones, which lay just below the surface of a beach area approximately one mile west of Decatur Boat Harbor, developed into more than the author suspected.

The process of amateur digging, though carefully done, developed into a study in archaeology because the skeleton was nearly complete and intact as a burial site. The author and nine year old son, who found the rib bones protruding to the surface, became linked with the past and its Indian history. For the present it is a hobby of thought and activity that brings much pleasure.

Abstracts

THE SEX OF THE ORIGINAL AMERIND ANCESTOR OF PART-INDIAN STUDENTS AT THE UNIVERSITY OF ALABAMA IN TUSCALOOSA

Margaret Z. Searcy
University of Alabama, University

The number of self-identified Indians living in Alabama according to the 1970 Census is 2,443, but the number of persons possessing some Indian ancestry, primarily through a female relative is far greater.

A questionnaire was answered by 182 University of Alabama students in 1972. Of these, 51 or 22% reported some Indian ancestry. All had checked either White or Negro as a racial classification on the Census. Forty-six listed their original Amerind progenitor as female; three did not know; and two had male ancestors.

Several interrelated factors explain the high percentage (92%) of female progenitors: matrilineal descent patterns among the Southern tribes; a surplus of Indian females in relationship to the males; an excess of males in proportion to the females among the Caucasoids; social factors favoring the Indian woman-Caucasoid male marriage but discouraging the Caucasoid female-Indian union; and the Indian Removal Act of 1830 which forced the emigration of the majority of the tribes.

Some Indian and part-Indian women remained in the state as the wives and/or descendents of white settlers. Many of these are the ascending female relatives of numerous present-day Alabamians.

POMPEII

Dixon Sutherland
Samford University, Birmingham, Alabama

The history of Pompeii, terminated by the eruption of the volcano Vesuvius, is one which involved the Oscans in the 8th century B.C., the Samnites in the 5th century B.C., and the Romans in 325 B.C. The *raison d'être* of the 24 acre city was Vesuvius, and in A.D. 79 it became the city's *raison de morte*.

The importance of Pompeii to the modern world is its archaeological value, i.e. being the best preserved city from all the ancient world, and thereby allowing the student of history to examine the everyday life of a first-century people. Excellent preservation of the gates, streets, and water system allows the study of ancient man's methods of living, while remains of the Forum and its monuments give insight into its political, economic and religious structure.

The housing system of Pompeii exhibits ancient methods of building as well as a contrast between the homes of the plebian and the patrician for at least five centuries. Most houses also included the business of the common Pompeian, and exposition of the industrial character of the Roman colony is evident.

Outside the city lies the necropolis of Pompeii, manifesting the burial customs and methods of these people, and revealing their views of death and life.

CULTURE: IDEAL PATTERNS TO PATTERNED SCANDALS AND BEYOND IN
AN ALABAMA COMMUNITY

Shelby K. Zeanah
University of Alabama, University

Characteristically, definitions of cultures stress ideal patterns and uniformities. Place is found, as Ralph Linton reports, for consistent internal differences (specialities) and allowable variations (alternatives). Some alternatives are so different that they are barely allowable, but they may be tolerated on the basis of human frailty. Beyond this, such words as deviations are used. Serious deviations are supposed to lead to sanctions.

I apply the foregoing to an Alabama town and its farming hinterland. It has had approximate population over many years of 1200. About one half reside in the central settlement and one half in the surrounding country. Whites outnumber Blacks two to one. (Blacks are omitted for simplicity.) The economic bases are farming, pulpwood, and cross ties. The religious affiliation is 50% Southern Baptist, 35% Methodist, and 15% other Protestants. The predominant sect of the Blacks is African Methodist Episcopal.

If asked, most whites would say that they lived in a good normal community. They generally do what good Christians and citizens are supposed to do. Men have their ways, of course, which differ greatly from women's ways, and there are occupational differences as well. Having alluded to the uniformities, and specialities, they would feel that the description was fairly complete. When pressed even a little, many respectable alternatives could be mentioned. With more pressure, backsliding and cases of real wrong doing would be recalled—and explained away. "Patterned scandals" in the title suggests these variations. At this point, a local informant would feel that he had told all.

My own inquiries reveal that serious deviations exist, and they rarely provoke clear sanctions, even though they were widely known. An instance of coercion (very effective) is cited. At the end I note the total absence of certain forms of deviant behavior.

ADDENDUM TO INDUSTRY AND ECONOMICS

MARKETING HEALTH INFORMATION IN AMERICA

Edgar Charles
School of Community and Allied Health Resources
Medical Center
University of Alabama, Birmingham

Between 1949 and 1950 total health expenditures increased by 555% and employment in the health occupations expanded by 109%. This massive shift of funds and people into the health sector has not brought about major improvements in the quality of health, as measured by various aggregate indices. The author submits that the major reason for this is because Americans are increasingly dependent upon health professionals
(Continued, p. 247)

Minutes

MINUTES ANNUAL BUSINESS MEETING JACKSONVILLE STATE UNIVERSITY, JACKSONVILLE April, 1972

The annual business meeting was called to order at 11:45 a.m. in the Student Commons Building by President G. O. Spencer, who moved that the minutes of the 1971 business meeting be approved without a reading. The reading of the minutes was waved and the meeting was begun.

REPORT OF THE SECRETARY (Tom Denton):

Additions:

New members, November 11, 1971 to April 13, 1972.	33
Reinstated members.	14
Contributing members.	1
Honorary members.	<u>1</u>
Total additions	49

Losses:

Dropped, November 11, 1971 to April 13, 1972.	7
Resigned.	3
Deceased.	<u>1</u>
Total losses.	11

New members by section are as follows:

1. Biological Sciences.	8
2. Chemistry.	2
3. Geology.	0
4. Forestry, Geography, and Conservation.	1
5. Physics and Mathematics.	2
6. Industry and Economics	4
7. Science Education.	4
8. Social Sciences.	1
9. Medical Sciences	1
10. Engineering.	4
11. Anthropology	<u>5</u>
Total.	33

Total membership for April 13, 1972. 974

REPORT OF THE TREASURER (W. F. Arendale). For the period January 1, 1971 through December 31, 1971:

RECEIPTS	ACTUAL	ESTIMATED
Membership dues	\$4,188.00	\$4,200.00
Annual meeting	1,158.00	1,000.00
Research grants	-	200.00
Miscellaneous		
Industry contributions to AJAS	1,875.00	2,300.00
Ala. Conference for College Biology	<u>175.04</u>	-
	\$7,326.04	<u>\$7,700.00</u>

Journal of the Alabama Academy of Science

EXPENDITURES	ACTUAL	BUDGET
Publication of Journal		
Printing	\$ 634.94	\$5,600.00
Honoraria for Editor	100.00	800.00
Assistance to AJAS		
Support	101.50	250.00
Industry Contributions	2,000.00	2,175.00
Student Awards	90.00	165.00
Research Grants	150.00	400.00
Annual Meetings		
Meals Cost, Host Institution	569.97	-
Expenses Net	-	250.00
Programs	534.65	350.00
Academy of Science Award	100.00	150.00
Speakers, Officers Expenses, etc.	-	200.00
Academy of Science Assessments	19.92	20.00
Operating Expenses		
Office of the President	50.00	125.00
Office of the Secretary	264.83	600.00
Office of the Treasurer	219.26	250.00
Office of the Editor-Newsletter	7.20	50.00
Office of Coordinator of Science Fairs	-	150.00
Office of the Counselor AJAS	-	-
Public Relations Committee	-	100.00
Supplies	-	200.00
Newsletter	-	100.00
Chairman, Membership Committee	-	150.00
Vice-Presidents (11 x \$20)	51.10	220.00
	<u>\$4,893.37</u>	<u>\$12,305.00</u>
Balance in Checking Account 12-31-70	\$5,669.79	
Total Receipts	7,326.04	
Total Expenditures	4,893.37	
Transferred to Savings Account 4-6-71	<u>-7,200.00</u>	
Balance in Checking Account 12-31-71	\$ 902.46	
First National Bank, Huntsville, Alabama, Savings Certificate		
Issued 7-22-69 Value 12-31-70	\$7,451.46	
Value 12-31-71	7,833.51	
First National Bank, Huntsville, Alabama, Savings Account		
Value 4-6-71	7,200.00	
Value 12-31-71	7,471.27	

After the Treasurer's report, Miss Merle Sherman reported that the Audits made of the AJAS and the AAS showed both Academies to be in good shape.

REPORT OF THE COMMITTEE ON THE PLACE OF MEETING (Robert Bauman):

"A survey of opinion concerning meeting sites has indicated the following as the principal criteria:

- a) No site should be chosen that does not have adequate housing facilities, as well as meeting facilities.

Minutes

b) Geographical distribution between areas of the State is preferred to a single central location.

c) If possible, the meetings should be on a college campus, especially for the benefit of the Junior Academy members.

The 1973 meeting has been set for Huntsville, April 5-7. The invitations from UAB for 1974 and from Auburn for 1975 have been accepted and an invitation has been received from the University of South Alabama for 1976."

REPORT OF THE RESOLUTIONS COMMITTEE (Richard Couch for Lillian Manley, Chairman):

"WHEREAS, the Alabama Academy of Science has held its Forty-Ninth Annual Meeting at Jacksonville State University and has enjoyed the hospitality of the University, therefore:

BE IT RESOLVED that the Academy express its gratitude to Dr. Houston Cole, President-Emeritus and Dr. Ernest Stone, President of Jacksonville State University; to Dr. Reuben B. Boozer, General Chairman and Coordinator of Local Arrangements; to Dr. L. G. Sanford, Chairman of Senior Academy Arrangements; to Dr. Virgil Benson, Chairman of Junior Academy Arrangements; and Dr. Rosemary Mainland, Chairman of Gorgas Foundation Arrangements; and to their committees; and to the Faculty and Staff of Jacksonville State University; and to all others who have contributed to the success of the meeting.

BE IT FURTHER RESOLVED that the Academy express its gratitude to the Sargent-Welch Company for their contribution to the annual banquet."

"WHEREAS, during the past year the Alabama Academy of Science has lost one of its members through death, therefore:

BE IT RESOLVED that the Academy extend its sympathy to the family of Dr. Harold Strickland.

BE IT FURTHER RESOLVED that an appropriate letter together with a copy of this resolution be sent by the Secretary of the Academy to the family of Dr. Strickland."

"BE IT FURTHER RESOLVED that the Academy express its gratitude to Professor G. O. Spencer for his effective leadership as President of the Academy during the 1971-72 year; for his interest in, support of, and active leadership in both Junior and Senior Academy activities over the past year; and to wish he and his wife well in their retirement years ahead."

REPORT OF THE NOMINATING COMMITTEE (E. L. Robinson, Chairman):

Elective Officers

President-elect: Robert Gudauskas (term 1972-1973)

Treasurer: Hoyt Kaylor (term 1972-1975)

Journal of the Alabama Academy of Science

Associate Counselor AJAS: Donald Grigsby (term 1972-1975)

Editor of Journal: Elroy Curl (term 1972-1974)

Trustees: W. B. Jones (term 1972-1975)
Sam Barker (term 1972-1975)
Walter Bouldin (term 1972-1975)
Lister Hill (term 1972-1975)

Section Officers

1. Biological Sciences

Vice-President: J. S. Brown
Vice-Chairman: Kenneth Landers

2. Chemistry

Vice-President: Virgil Benson
Vice-Chairman: Samuel McManus

3. Geology

Vice-President: Denny Bearce
Vice-Chairman: Ronald Taylor

4. Forestry, Geography, and Conservation

Vice-President: John Bourne
Vice-Chairman: John Hinton

5. Physics and Mathematics

Vice-President: Raymond Cooper
Vice-Chairman: O. Essenwanger

6. Industry and Economics

Vice-President: Charles Leoins
Vice-Chairman: Jack Duncan

7. Science Education

Vice-President: Ernest Riggsby
Vice-Chairman: Myrtle Alexander

8. Social Sciences

Vice-President: Wesley Newton
Vice-Chairman: Virgil Davis

Minutes

9. Medical Sciences

Vice-President: Ed M. Weller
Vice-Chairman: Allen Hisey

10. Engineering

Vice-President: John Cochran
Vice-Chairman: Thomas Cost

11. Anthropology

Vice-President: E. Earle Smith, Jr.
Vice-Chairman: Helen Mabry

John Holland announced the Outstanding Science Teacher Award and the AJAS officer's award, with John Smith of Muscle Shoals High School receiving the latter.

The Research Committee of the Academy of Science received one request for a research grant. Miss Merle Sherman reported that Ralph Bunn, a student in Anthropology at the University of Alabama, has been granted \$150.00 to continue his study of dental material from Pinson Cave.

REPORT OF THE STATE COORDINATOR, REGIONAL SCIENCE FAIRS (George O. Twellmeyer):

"The seven Regional Science Fairs of Alabama with their respective Coordinators and Coordinating Institutions are as follows:

Central Region: Ben B. Chastain, Samford University
Mobile Region: G. O. Twellmeyer, S.J., Spring Hill College
Northern Region: Donald Caplenor, Huntsville Center, U of A
Northeastern Region: Clyde J. McSpadden, Jacksonville State University
Northwestern Region: Hollis C. Fenn, Florence State University
Southern Region: William Norman, Troy State University
Western Region: James L. Nisbit, University of Alabama

"All of the Regional Science Fairs of Alabama now hold contracts with Science Service and will each send two Finalists to the International Science and Engineering Fair to be held in New Orleans, La., April 30-May 6. Adult companions for the fourteen Finalists will be Miss Linda Lou Lindsey from the Northwestern Region and Mr. Michael Thrash from the Western Region. Mrs. R. L. Crawford, Jr., from the Mobile Region will be the third companion since there is some doubt as to whether Father Twellmeyer will be able to attend.

Dates set by the Science Fair Committee for Regional Fairs for the next three years are as follows:

1973 Easter-April 22	Fair Date-March 22-24
1974 Easter-April 14	Fair Date-March 21-23
1975 Easter-March 30	Fair Date-March 20-22

Journal of the Alabama Academy of Science

Efforts are still being made to set up a Science Fair in the Auburn area so that the State will be fully covered."

Finalists representing the seven Regional Fairs of Alabama:

Central Region, Samford University: Salina Cason, Joseph F. Gravlee

Mobile Region, Spring Hill College: Marie L. Leach, Greg Cooper

Northern Region, University of Alabama, Huntsville: Vickie Gothard,
Barry McGahan

Northeastern Region, Jacksonville State University: James C. Frinak,
Steven R. Jones

Northwestern Region, Florence State University: Gale Tingle, Mitchell
Pate

Southern Region, Troy State University: Paul Hughes, Brenda Holstead

Western Region, University of Alabama, University: Buddy Partridge,
Rhett Burge

Dr. Emmett B. Carmichael then presented the names of the Gorgas Scholarship Winners as follows:

First Award: Bonnie Jean Luessen, Virgil I. Grissom High School,
Huntsville.
Subject: Von Karman vortex.

Second Award: Susan Garmon, Austin High School, Decatur.
Subject: Paramecium clock.

Third Award: Linda Ann Ferguson, Bradshaw High School, Florence.
Subject: Photosynthesis.

Fourth Award: Kerry Lynn Standridge, Austin High School, Decatur.
Subject: Earthworm pheromone.

First Alternate: David Bruce Crider, Minor High School, Birmingham.
Subject: Pollution biology.

Second Alternate: Yvonne Wallace, Parker High School, Birmingham.
Subject: Citrus oils.

Third Alternate: Jackie Houston Harrison, Andalusia.
Subject: Liesegang bands.

Fourth Alternate: Stanley Keith Grayson, Greenville High School, Greenville.
Subject: Zener diodes.

Minutes

Fifth Alternate: Rory Cole Waters, Lawrence County High School, Moulton.
Subject: Coral periodicity.

"The judges who selected the finalists are faculty members of Athens College. Dr. William A. Short, Chairman, Division of Natural Sciences and Mathematics, Athens College, is Chairman of the Judges Committee. Other committee members include Dr. Emmett B. Carmichael, University of Alabama in Birmingham, and Dr. Charles E. Feazel, Southern Research Institute.

The scholarships each provide college tuition for four years plus a cash award up to \$450 each year. The Gorgas Foundation is named for General William Crawford Gorgas, the Alabama physician who conquered yellow fever in the Panama Canal Zone while serving as Surgeon General of the U.S. Army. The purpose of the Foundation is to promote interest in science and to aid in the education of promising students."

This being the last of the reports, President G. O. Spencer turned the meeting over to President-Elect Joseph Thomas, who complimented President Spencer for the outstanding work he has done as President of the Academy this year.

After some appropriate comments by Dr. Carmichael, President Thomas adjourned the meeting at 12:15 p.m.

ERRATUM

Vol. 43(2). April 1972. Charles T. N. Paludan. Environmental Land-Use Applications from Space Research, p. 131, Figure 6. The county contiguous to Madison on the map should be Limestone.

Abstracts

Marketing Health Information (Continued from p. 238)

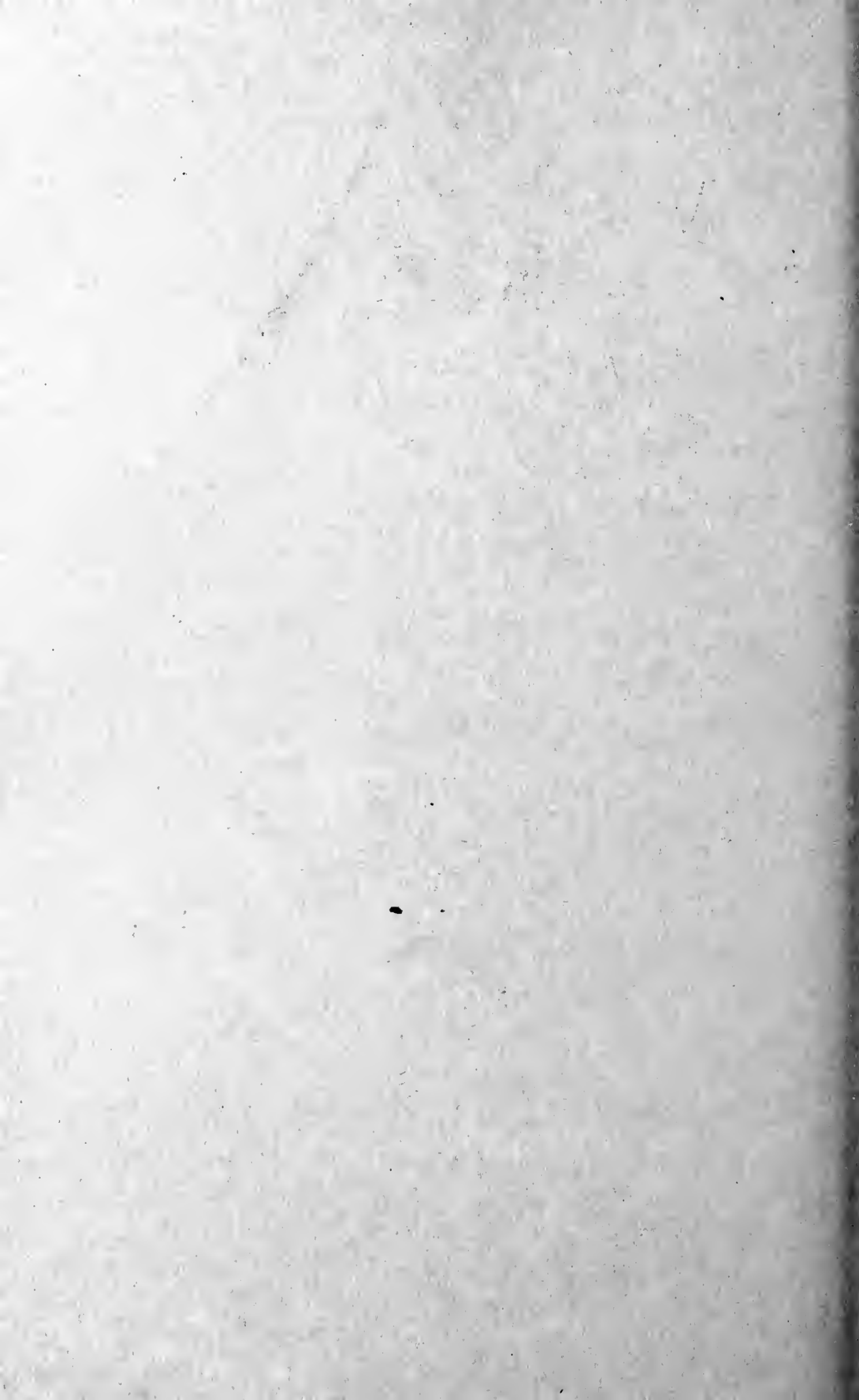
and have assumed less of a personal responsibility for health maintenance. Many health authorities recognize that an expansion of personal health maintenance will require a much more knowledgeable health oriented public. A study of the public's health knowledge by the National Opinion Research Center revealed that most of the public's health knowledge is obtained from the mass media and hearsay--very little information is received from health professionals. Since the mass media is the most important influence upon public health knowledge, Smith, Trivax, Zuehlke, and Ngheim monitored a commercial television channel to analyze the health content. Health related messages used 7.2% of the time. However, only 30% of the time offered useful information and 70% was inaccurate or misleading or both.

Although some health information must be disseminated on a one-to-one basis by health professionals, resource limitations and economic efficiency necessitates the delivery of most information by the mass media.

Increasingly, the techniques of advertising and marketing developed by the private sector are being used to attack social and economic problems (termed "social marketing") and some authorities argue that advertising can bring about fundamental behavioral changes. Although behavioral modification via marketing is debatable, there is little doubt that the combined efforts of health educators, social marketers, physicians, and psychologists interested in behavioral modification can develop programs to greatly improve the public's health knowledge.







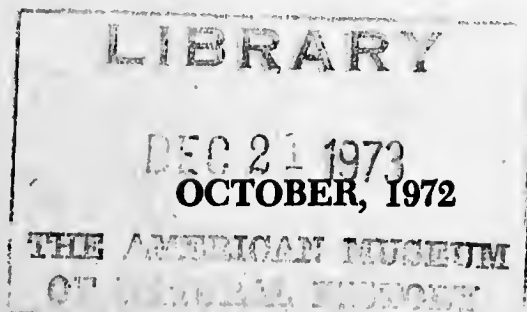
5.06 (26.1) B

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

OFFICE OF THE EDITOR
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830

VOLUME 43



NUMBER 4

THE JOURNAL
OF THE
ALABAMA ACADEMY
OF SCIENCE

**AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE**

VOLUME 43

OCTOBER, 1972

NUMBER 4

EDITOR

Elroy A. Curl
Auburn University

ARCHIVIST

Clyde H. Cantrell
Auburn University

EDITORIAL BOARD

Lowell Wilson, Chairman
Auburn University

A. F. Hemphill
Spring Hill College

Ann Everett
Plainview High School

E. L. McGraw, Auburn University, Editorial Consultant

The Journal of The Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

CONTENTS

ARTICLES

Major Influences of Three New Deal Agencies on Education in the United States Prior to 1944 Jacquelyn M. Diener	248
Deep-Well Disposal of Liquid Wastes in Alabama Charles D. Haynes	259
An Early Attempt at Wage and Price Controls: Diocletian's Edict of 301 A.D. James W. Park	278
Economics in the Social Sciences Curriculum Kenneth E. Van Sise	284
Industry Structures and Logistics Strategies Grant M. Davis	289
George Wishart: His Role in the Scottish Reformation Movement Richard Glen Eaves	302
INDEX	316

Major Influences of Three New Deal Agencies

MAJOR INFLUENCES OF THREE NEW DEAL AGENCIES ON EDUCATION IN THE UNITED STATES PRIOR TO 1944

Jacquelyn M. Diener
Auburn University
Auburn, Alabama

INTRODUCTION

The United States (US) experienced a cultural upheaval in the 1930's. The patterned ways of behavior were changed drastically for millions of people by the "Great Depression." One-sixth of the population of the US was on relief in March, 1933. Payments averaged fifty cents a day per family.¹ Other millions in all trades and professions were also affected by the depression. Few college professors, for example, felt actual want or privation but continuing in their usual modes of living was difficult, if not impossible, because salaries were cut and few had savings. Before March 4, 1933, the US was in a state of extreme shock.²

In the early years of Roosevelt's administration and throughout the 1930's the daily struggle for survival was common. In 1937-1938 the US was hit by business recession; some individuals were living on twelve cents per day for food, some were begging from door to door and foraging in garbage cans, others were dying from lack of expensive drugs, evictions were a daily occurrence and suffering was widespread.³

Surely, the economic and social problems of the 1930's must have been the worst of any generation in the United States. In such times education is often pushed to the background. However, Roosevelt's New Deal (ND) did provide for education, and in their 1936 Platform the Democrats proudly proclaimed: "We have aided youth to stay in school; given them constructive occupation; opened the door to opportunity. . . ."

Millions of Americans, especially educators, welcomed federal aid to education. The 1937 Platform of the National Education Association (NEA) endorsed the federal government's assistance "to the states in making an adequate education available to every child and adult."⁵

In the following study, only those agencies of the ND that appeared to have the most direct influence on education prior to 1944 are discussed. These agencies are discussed without analyzing the organizational structure of each within the broader structure of the ND. The term "New Deal" is used generally rather than with reference to a second or third ND. The discussion shows acceptance of ND assistance and does not cite adverse criticisms prevalent in the literature. Finally, the major influences of three ND agencies on education prior to 1944 are identified.

THREE NEW DEAL AGENCIES

The three agencies selected for their direct contribution to education were the Civilian Conservation Corps (CCC), the Works Progress Administration (WPA), and the National Youth Administration (NYA).

Civilian Conservation Corps

The CCC was a program close to Franklin D. Roosevelt's heart, and according to several authors, this program would have pleased Theodore Roosevelt. Frances Perkins, Secretary of Labor, described FDR's attitude towards CCC:

He would insist in his way of thinking that all of these institutions should accept and practice a moral responsibility for making the life of the individuals who make up the life of the common people "more decent," and in the common people he included the rich and the poor alike. I remember that he wanted to find a way for well-to-do boys, as well as relief boys, to go to CCC camps to get the advantages of the training and democratic living.⁶

The CCC was the third program of the ND approved by Congress during FDR's first "one hundred days." From 1933 to 1944, CCC enlisted over 2,250,000 members. Current enrollments were limited to 300,000, and membership was limited to men between the ages of 18 and 25. Enrollment was for not less than six months and not more than two years. Men received \$30 a month; \$25 of that was sent to their families, most of whom were on relief.⁷⁻¹¹

What the CCC boys did for the US made quite a record. They lived in camps throughout the country and were kept busy in reforestation, soil conservation, irrigation, fire fighting, destruction of insect pests and plant and animal diseases. They planted seventeen million acres in new forests and built over six million check dams to halt soil erosion.¹²⁻¹⁴

What did CCC do for its nearly three million members? It took these young men, unemployed and without resources, off the streets, roads, and rails. The CCC gave them board and lodging in camps, and put them to work on useful projects. CCC gave them an opportunity for training, education, self respect, and hope for the future.^{15,16}

Each CCC Camp had a unique educational program that was part of a well organized total program. C. S. Marsh, CCC Educational Director, described the program in detail. The US Office of Education approved their educational plan, appointed Camp teaching personnel, and served in an advisory capacity to the War Department concerning teaching procedures, study materials, etc. Marsh described in detail the entire CCC organization from the War Department's nine Corps Areas to the daily meetings of educational personnel.^{17,18}

No matter how varied the individual Camp programs, the educational aims of all the Camps as given in the *Handbook for CCC Camp Educational Advisors* were:

1. To develop in each man his power of self-expression, self-entertainment, and self-culture.
2. To develop pride and satisfaction in cooperative endeavors.

Major Influences of Three New Deal Agencies

3. To develop as far as practicable an understanding of prevailing social and economic conditions, to the end that each man may cooperate intelligently in improving these conditions.
4. To preserve and strengthen good habits of health and of mental development.
5. By such vocational training as is feasible, but particularly by vocational counseling and adjustment activities, to assist each man better to meet his employment problems when he leaves camp.
6. To develop an appreciation of nature and of country life.¹⁹

The educational program fell into four fields:

1. Vocational subjects: designed to teach work skills.
2. Fundamental subjects: designed to teach illiterates.
3. Academic subjects: included subjects common to high school curricula.
4. Self expression subjects: designed to teach wise use of leisure time.²⁰

John W. Studebaker, US Commissioner of Education in 1935, endorsed the CCC program because it provided an opportunity for two types of secondary and elementary education that could not be provided in the cities and small villages.²¹ Some classes were held in nearby colleges and public schools and in classrooms on the Camp site. Students received high school and college credits from these classes and through correspondence courses. The program to which Studebaker seemed to be referring was the daily work of the CCC boys. On the daily job, with technically trained supervisors, the boys learned about explosives, road building, bridge construction, forestry, soil erosion, insects, plant and animal diseases.^{22,23}

Works Progress Administration

The WPA was in existence from 1935 to 1944, during which it employed over 8,000,000 people. Individuals employed by WPA were dropped from state and local relief programs. Anyone offered private employment became ineligible for WPA work. WPA hired only employables, they worked for the federal government for approximately \$52.00 per month. WPA wages were remuneration for work, not a relief dole and, as such, wages could be spent as the person who earned them chose. This principle of freedom of the individual helped to restore the pride of millions of people who had previously been wards of relief agencies. Based on this principle, WPA became one of the most successful programs of the New Deal. WPA regenerated its workers, preserved their skills, taught them new skills and enriched the culture of the US.

WPA spent over \$11.4 billion. Most of the money was spent for construction of streets and roads (approximately 457,000 miles) and construction or repair of public buildings (approximately 88,000 buildings, including recreation areas, airports, etc.). Approximately 75% of the American

farmers carried their children to school over WPA farmer-to-market roads. Rural schools of many states were repaired or rebuilt. About one-fifth of the money went for community service projects that employed people with all kinds of skills. Among these projects were adult education classes (WPA helped reduce illiteracy to less than one percent). These classes enabled Negroes and other minority groups to get better jobs. Adult education classes trained over 400,000 unemployed women factory workers in homemaking skills. One project of these women was the hot school lunch program that was new to most schools. Other WPA projects included the financing of state and local statistical research projects particularly in connection with universities. These research projects, adult education classes, and WPA sponsored nursery schools employed thousands of unemployed teachers.²⁴⁻³⁸

The CWA and WPA were responsible for constructing about \$11,000,000 worth of school buildings in Alabama, only \$5,000,000 of which was supplied from state and local funds.³⁹ Hayes, Supervisor of Adult Emergency Education in Alabama, stated that WPA schools for adults in Alabama were responsible for bringing further instruction to 20,179 people at elementary levels, to 8,366 people at high school levels, and to 631 on college levels. In just one year, 12,355 Alabama adults were taught to read and write for the first time.⁴⁰ Subject matter and vocational courses were so successful that Hayes recommended that a program of adult education become a part of the state plan of education and be financed along with elementary, high school, and college programs.

The WPA set up several white collar programs. For the first time in American history, the federal-government gave vast subsidies to the fine arts through such programs as Federal Art, Federal Music, Federal Writers and Federal Theater.

Federal Art Project. Through the Federal Art Project (FAP), the general public became educated in art, as never before, during the 1930's. Thousands of people, who would never enter museums, viewed murals, easel paintings and other works created by artists employed by the WPA Federal Art Project. Many people attended WPA art classes. Approximately 52,000 easel paintings were created by FAP artists and placed on permanent loan to schools, libraries, and hospitals. More than 15,000 murals were painted in tax-supported public institutions in all parts of the US, such as high schools, post offices, and town halls, and frequently visited such places as the Justice and Interior Department buildings in Washington, D.C. According to critics, government-sponsored art ranged from worthless to very fine. FAP art created an artistic-renaissance and brought new meaning to the lives of ordinary citizens.⁴¹⁻⁴⁵

Federal Music Project. The Federal Music Project (FMP) brought live music to the people; more than one hundred million people attended free concerts. FMP sponsored orchestras, concerts, and music classes. Music teachers in schools increasingly tried to teach "music appreciation." Music lessons were given to thousands of applicants, who could not afford to pay for private instruction. FMP programs featured folk music, formal music and especially music by American composers. Electrically powered radios and record players improved during the 1930's and were used by FMP workers as aids in teaching and in reaching vast audiences. FMP created

Major Influences of Three New Deal Agencies

widespread interest in music and laid the foundation for the great upsurge of interest in music after World War II.⁴⁶⁻⁴⁸

Federal Theater Project. The techniques and dramas of WPA's Federal Theater Project (FTP) ranged from poor to excellent. FTP left a permanent impression upon the American theater; the project employed about 9,000 theater workers who played before audiences of over 25 million in three years. These audiences were in schools, CCC camps, prisons, reformatories, asylums, hospitals and regular theaters. The audiences included rich, poor, young, old, students in colleges, housewives, sharecroppers, lumberjacks, and over a hundred thousand children who had never seen a play before. Great regional theaters were developed in the East, West, Midwest and South. Each region developed its own unique programs adapted to that region within the context of the national program. Each had a director who worked with the various companies in his region.⁴⁹⁻⁵¹

Federal Writers Project. The WPA Federal Writers Project (FWP) produced the FWP guidebooks, *The American Guide*, for all of the states and many cities. These remain the best that have ever been compiled. FWP conducted long needed research for each state and collected a great deal of historical material that otherwise might have been lost.^{52,53}

One of WPA's greatest accomplishments was exposure of the masses to the fine arts, thus creating interest and enthusiasm for art, music, drama, and history. This newly developed appreciation of the arts helped people to see that making a living was not an end in itself, but that really rich living depended upon a breadth of culture and self-advancement in understanding of their own American culture.^{54,55}

National Youth Administration

The same law that created WPA also provided for the National Youth Administration (NYA). NYA had a greater influence on the lives of youth than perhaps any other ND agency. NYA's main purpose was to provide part-time employment for students in high school and college; its secondary purpose was to provide work-projects for school dropouts. The first constituted a work-scholarship program, the latter vocational training. NYA assisted approximately 40,000 of the hundreds of thousands of unemployed teachers by hiring them to teach in NYA programs.⁵⁶⁻⁶⁰

The selection of students for NYA jobs was on the basis of need. The schools, colleges, and universities, not the federal government, controlled selection; NYA students worked in libraries, and laboratories, did clerical work, and assisted faculty members in research projects and grading of papers. Some research projects, such as the Lorge-Thorndike *Semantic Count of English Words*, highly important in teaching readings and compiling dictionaries, could not have been completed without NYA assistance. These and other worthwhile contributions were made by over 400,000 young people who were able to stay in school with the help received from NYA.^{61,62}

NYA was credited with helping students to stay in school and further credited with helping to meet the needs of "all young people in a mechanical age;" toward this purpose the US Office of Education and the NYA agreed:

The function of the U.S. Office of Education is to secure the development and operation of educational or training programs for all youth, and the function of NYA is to organize and administer programs of work for needy or selected youth.⁶³

Through employment given them by the student-work division of NYA prior to 1942, 16,793 boys and girls in Alabama were enabled to continue their education. Of this number, 14,139 were in public school, and 2,600 were in college.⁶⁴

SUMMARY AND CONCLUSIONS

The CCC, WPA, and NYA were the three ND agencies that had the most influence on education prior to 1944. The CCC provided an opportunity for young men to learn conservation and construction skills and pursue academic studies. WPA's main effect on education was the preservation of adults' skills and the subsequent effect this had in teaching other adults and children new skills and appreciations especially in reading, writing, vocational work, and the fine arts. NYA's major effects were: 1) the immeasurable improvements in the lives of individuals who were helped to stay in high school and college and 2) making it possible for others of all ability levels to attend, and resulting in the upgrading of high school curricula to meet the needs of individuals in changing times.

In a comparison of the effects of CCC, WPA, and NYA, it appeared that some effects were the same or similar, others discrete. Without re-identifying those pertaining to each agency, generally the major influences (or effects) on education prior to 1944 are listed:

1. Educational opportunities were broadened and participating individuals were given pride, self-confidence, and hope for the future.
2. Individuals were taught to be responsible citizens through academic studies and vocational experiences which increased their ability to make worthwhile contributions in a democratic culture.
3. Public support of education was increased, federal aid became more acceptable, and the stimulation for self improvement caused public schools to become overcrowded and college attendance reached a record high.
4. Educators realized that one essential part of education is practical experience; therefore, high school curricula were changed to include vocational education.
5. The influx of students of all ability levels into the schools speeded curricula changes to meet the needs of individual students; high schools included not only college preparatory courses but also courses to prepare students for a productive adult life without college education.

Major Influences of Three New Deal Agencies

6. Educators recognized the importance of adult education and took steps to include it in their plans for public education.
7. Thousands of illiterate adults learned to read and write; and the new minimum standard for youth became a high school education.
8. Federal aid to education increased communication through improved transportation (roads) and "modern" use of teaching aids (radio, record player).
9. The cultural climate was increased by the federal government's large appropriations of money to the fine arts (art, drama, music, writing); subsequently for the first time millions of average people including many public school students had an opportunity to appreciate these cultural activities as vocations and as aesthetically important to their wise use of leisure time.
10. The exchange of ideas was facilitated and a new pride in America resulted from education programs that were conceived locally for the first time within the context of regional and national programs.
11. The construction and repair of educational buildings, athletic fields, and recreational areas provided improved facilities for educational, health and recreational programs.
12. The importance of nursery school programs became widely recognized and many were established.
13. Hot school lunch programs became more common.
14. Thousands of unemployed teachers were hired by the federal government.
15. Family life was strengthened as young men sent most of their earnings home while they were acquiring the economic stability and skills to establish families of their own.
16. *The American Guide* and the *Semantic Count of English Words* were works of such gigantic proportions that no publishing company would handle their compilation. These works by WPA and NYA contributed to Americans' better understanding of reading, lexicography, and history.

FOOTNOTES

¹Harry L. Hopkins, "The War on Distress," in *New Deal Thought*, ed. by Howard Zinn (New York: Bobbs-Merrill Company, 1966), pp. 151-52.

²Committee Y, "The Reaction of Faculties to the Depression," *Bulletin of the American Association of University Professors*, XXII (October, 1936), 377-89.

³Samuel Lubell and Walter Everett, "The Breakdown of Relief," in *New Deal Thought*, ed. by Howard Zinn (New York: Bobbs-Merrill Company, 1966), p. 297.

⁴Henry Steel Commanger, ed., "The Democratic Platform of 1936," in *Documents of American History Since 1898*, II (New York: Appleton-Century-Crofts, 1968), p. 360.

⁵Editor, "Platform of the National Education Association," in *The Journal of the National Education Association*, XXV (January, 1936), 29-31.

⁶Frances Perkins, "FDR Was a Little Left of Center," *New Deal Thought*, ed. by Howard Zinn (New York: The Bobbs-Merrill Company, Inc., 1966), p. 385.

⁷Paul K. Conkin, *The New Deal* (New York: Thomas Y. Crowell Company 1967), p. 47.

⁸David A. Shannon, *Twentieth Century America: The United States Since the 1890's* (Chicago: Rand McNally and Company, 1963), p. 344.

⁹Wallace E. Davies, *The New Deal: Interpretations* (New York: The MacMillan Company, 1964), p. 42.

¹⁰Arthur M. Schlesinger, Jr., "The Hundred Days of the New Deal," in *Readings in American History Since 1865*, ed. by Glyndon G. Van Deusen and Herbert J. Bass, II (New York: MacMillan Company, 1968), p. 380.

¹¹David A. Shannon, *Between the Wars: America, 1919-1941* (Boston: Houghton Mifflin Company, 1965), p. 157.

¹²Oscar Theodore Barch, Jr. and Nelson Manfred Blake, *Since 1900: A History of the United States in Our Times* (New York: The MacMillan Company, 1965), p. 457.

¹³Henry Steele Commanger, "Twelve Years of Roosevelt," in *The New Deal: Revolution or Evolution?* ed. by Edwin C. Rozwenc (Boston: D. C. Heath and Company, 1959), p. 22.

¹⁴Editors of *The New Republic*. "The New Deal in Review 1936-1940," in *The New Deal: What Was It?* ed. by Morton Keller (New York: Holt, Rinehart and Winston, 1963), pp. 67-68.

Major Influences of Three New Deal Agencies

¹⁵*Ibid.*

¹⁶Barch and Blake, *United States in Our Time*, p. 457.

¹⁷C. S. Marsh, "The Educational Program in the Civilian Conservation Corps During the Third Enrollment Period (April 1-Sept. 30, 1934)," *The Educational Record*, XVI (January, 1935), 7.

¹⁸C. S. Marsh, "Vocational Training in CCC," *High School Teacher*, XI (March, 1935), 74.

¹⁹C. S. Marsh, "The Educational Program," p. 4.

²⁰*Ibid.*, 12.

²¹John W. Studebaker, "A Program for the Office of Education," *The Educational Record*, XVI (July, 1935), 303.

²²Marsh, "Vocational Training," pp. 74, 175.

²³Marsh, "The Educational Program," pp. 12-14, 19.

²⁴Committee Y, "Effect of Depression and Recovery on Higher Education," *Bulletin of the Association of University Professors*, XXII (January 1936), 33.

²⁵Studebaker, "Program for the Office of Education," p. 303.

²⁶Josephine Chapin Brown, *Public Relief 1929-1939* (New York: Henry Holt and Company, 1940), pp. 167-68.

²⁷Dexter Perkins, *The New Age of Franklin Roosevelt: 1932-1945* (New York: Rand McNally & Company, 1957), p. 30.

²⁸Conkin, *The New Deal*, pp. 58-59.

²⁹Arthur M. Schlesinger, Jr., "The Broad Accomplishments of the New Deal," in *The New Deal: Revolution or Evolution?* ed. by Edwin C. Rozwenc (Boston: D. C. Heath and Co., 1959), p. 30.

³⁰Davies, *New Deal Interpretations*, pp. 39, 120.

³¹Samuel Lubell, "Revolt of the City," in *The New Deal: What Was It?* ed. by Morton Keller (New York: Holt, Rinehart & Winston, 1963), pp. 473-74, 502, 505.

³²Shannon, *United States Since the 1890's*, pp. 343-44.

³³Editors of *The New Republic*, "New Deal in Review," pp. 62-3, 68.

³⁴Barch and Blake, *United States in Our Times*, p. 473.

³⁵Harry L. Hopkins, *Spending to Save* (New York: W. W. Norton & Company, Inc., 1936), pp. 114, 123, 168-9, 171-2, 178.

³⁶Shannon, *Between the Wars: America, 1919-1941*, p. 163.

³⁷Louis M. Hacher, "The Third American Revolution," in *The New Deal: Revolution or Evolution?* Edited by Edwin C. Rozwenc (Boston: D. C. Heath and Company, 1959), p. 10.

³⁸Hopkins, "The War on Distress," p. 155.

³⁹Delos Poe Culp, "Alabama School Revenue from 1900-1939" (unpublished Master of Science Thesis, Alabama Polytechnic Institute, 1940), p. 90.

⁴⁰Marguerite P. Hayes, "Some Aspects of Adult Education," *Alabama School Journal*, LIX (November, 1936), 7, 19.

⁴¹Hopkins, *Spending to Save*, p. 175.

⁴²Barch and Blake, *United States in Our Times*, p. 533.

⁴³Editors of *The New Republic*, "New Deal in Review," p. 68.

⁴⁴Lewis Mumford, "The Government Should Support Art," in *New Deal Thought*, ed. by Howard Zinn (New York: The Bobbs-Merrill Company, Inc., 1936), pp. 166-72.

⁴⁵Shannon, *United States Since the 1890's*, pp. 406-07.

⁴⁶*Ibid.*, 408-09.

⁴⁷Barch and Blake, *United States in Our Times*, p. 534.

⁴⁸Editors of *The New Republic*, "New Deal in Review," p. 68.

⁴⁹*Ibid.*, 68-9.

⁵⁰Hallie Flanagan, "The Drama of the Federal Theater Project," in *New Deal Thought*, ed. by Howard Zinn (New York: The Bobbs-Merrill Company, Inc., 1966), pp. 174-8.

⁵¹Davies, *New Deal Interpretations*, p. 41.

⁵²*Ibid.*

⁵³Hopkins, *Spending to Save*, pp. 176-177.

⁵⁴Editors of *The New Republic*, "New Deal in Review," p. 69.

⁵⁵Barch and Blake, *United States in Our Times*, p. 535.

⁵⁶Editors, "Youth, Culture, and Education," in a Special Supplement of *The New Republic*, June 10, 1936, p. 153.

⁵⁷Editors of *The New Republic*, "New Deal in Review," p. 68.

Major Influences of Three New Deal Agencies

⁵⁸Conkin, *The New Deal*, p. 59.

⁵⁹Shannon, *Between the Wars: America, 1919-1941*, p. 163.

⁶⁰Shannon, *United States Since the 1890's*, p. 389.

⁶¹Hopkins, *Spending to Save*, p. 172.

⁶²Barch and Blake, *United States in Our Times*, p. 474.

⁶³John E. Bryan, "The NYA and the School," *Alabama School Journal*, LIX (October 1941), 13.

⁶⁴Corinne Dickinson Millsap, "The Development of the National Youth Administration in Conecuh County" (unpublished Master of Science thesis, Alabama Polytechnic Institute, 1942), pp. 18-27, 29-34.

DEEP-WELL DISPOSAL OF LIQUID WASTES IN ALABAMA

Charles D. Haynes
College of Engineering
University of Alabama, University

INTRODUCTION

Increasing emphasis on pollution abatement has prompted a search for alternative methods to dispose of liquid wastes. One such method is to dispose of these wastes in deep-lying rock strata using wells. The concept of subsurface disposal of liquid wastes may be considered as the "opposite" of ground water production, although the same physical parameters are involved. A water well is deemed "productive" if the output is high per increment of pressure drawdown. A disposal well is considered "successful" if the input is high per increment of pressure buildup. A disposal reservoir must have void space (porosity), ability to transmit fluids (permeability), and sufficient thickness and lateral extent (geometry). In addition, it should be isolated by impermeable formations above and possibly below. These confining beds must be capable of preventing the migration of wastes from the selected disposal zone. The liquid waste and native formation liquid must be chemically compatible to insure that *in situ* plugging will not occur. A typical disposal well is shown in Figure 1.

PROPERTIES OF THE ROCK

Past experience has shown that sedimentary rocks provide better disposal characteristics than other rock types. In addition to specific characteristics of the individual particles that comprise the rock mass, sedimentary rocks possess properties of porosity, permeability, and strength. These latter factors depend on the properties of the particles themselves as well as the degree of cementation, compaction, and structural deformation of the rock.

Porosity

Some degree of void space is usually present in all rocks. The extent of this void space is termed the porosity of the rock, and is expressed as the ratio of the volume of void space to the total volume of the rock. It is usually given as a percentage. Two types of porosity may exist; one type is associated with the fracture network, if any, and the other with the matrix, or unbroken rock. Matrix porosity can range to a theoretical high of 47 percent, assuming uniform spherical grains center-packed, but rarely exceeds 35 percent and is commonly less than 10 percent. Gross porosity, the sum of matrix and fracture porosity, is the essential measure of a rock's ability to store liquids. For example, a porosity of one percent is equivalent to a total volume of 3,258 gallons of void space per acre-foot of bulk volume.

A potential disposal formation must have sufficient porosity to warrant development and usage. Porosity alone, however, is not the unique requirement, since these void spaces must be interconnected and be of

Deep-Well Disposal of Liquid Wastes

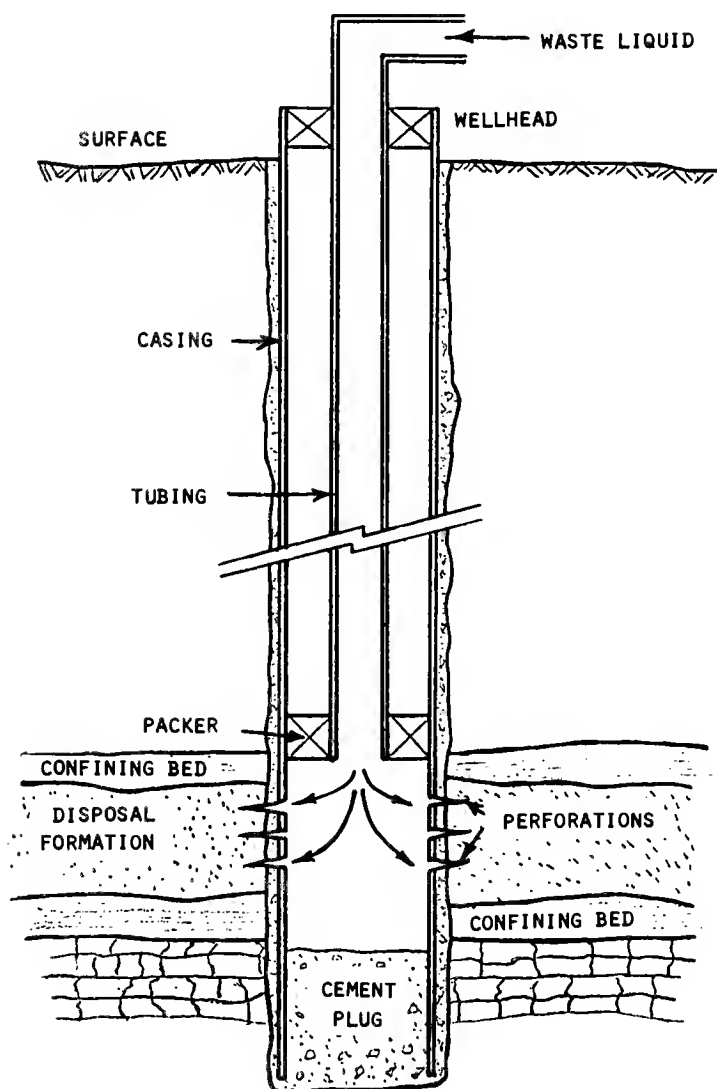


FIGURE 1. Typical liquid waste disposal well.

sufficient size to permit the movement of fluids. Hence, some degree of permeability must exist.

Permeability

The permeability of a rock is its capacity for transmitting a fluid. The degree of permeability depends upon the size and shape of the pores, and the size, shape, and extent of interconnected openings. Permeability cannot exist without porosity, but porous rocks may lack permeability. A good example in the latter case is pumice or other volcanic ash material.

Permeability is measured by the volume of a fluid of given viscosity that can move a certain distance through a porous medium in a specific interval of time under a constant differential pressure. More specifically, if

1 cubic centimeter of a fluid having
1 centipoise viscosity can travel
1 centimeter in a rock of
1 square centimeter cross-sectional area in
1 second of elapsed time, the rock has
1 *darcy* permeability.

Rocks having one darcy permeability are very rare. More commonly, the millidarcy (one-thousandth of a darcy) is used to describe permeability in subsurface rocks.

Formation Geometry

The size and shape of a porous and permeable formation is important in its use for subsurface disposal. As a general rule, most sediments have a beginning, a maximum thickness, and an ending. Thus, every rock layer tends to assume the shape of a lens. The area of these layers may vary from a few square feet to several million square miles and vary in thickness from a fraction of an inch to hundreds of feet. A river-sand deposit may be long and narrow whereas the sands of an ancient delta will be spread over a wide area as an open fan.

After burial, the layers of sedimentary rock are subjected to compaction and to varying degrees of crustal deformation. In some areas, bending, folding, and faulting have occurred. Faulting can abruptly terminate the continuity of a disposal reservoir, acting as a seal. Other faults permit the free movement of fluids along the fault plane.

The present structural position of rock strata and the degree of faulting are important to the consideration of a disposal formation. The subsurface depth of the disposal formation is reflected in the drilling cost necessary to reach it from the surface.

Confining Rocks

The success of subsurface liquid waste disposal depends on the confining of the waste material in known areas. If confinement is not accomplished, there is the possibility of waste liquid migration and the subsequent contamination of fresh water supplies near the earth's surface. An essential requirement of the confining formations is near-zero permeability vertical to the bedding planes. The most common impervious sedimentary rock is shale. It is fine grained and resists fracturing. In most cases, a thickness of 20 feet of shale is sufficient to prevent the vertical migration of waste liquids. Shales are common in sedimentary geologic columns, and their detection and delineation are easily made by electric logging techniques.

Gypsum and salt, both evaporite rocks, have near-zero porosity and permeability. Since they tend to resist permanent fracturing, evaporites make excellent confining beds.

Other types of sedimentary rocks, including chert, silt stones, dense unbroken carbonates, clay-filled sandstones, and tightly cemented sandstones,

Deep-Well Disposal of Liquid Wastes

often are suitable as confining beds, provided the matrix permeability is very low and fracture permeability does not exist.

CHEMICAL COMPATIBILITY OF COMPONENT LIQUIDS

The potential reaction between injected liquid wastes and the native reservoir fluid has been the subject of study and debate, and differing opinions concerning the effect of liquid incompatibility on the permeability have been offered by several authors. Selm and Hulse (1) listed several classes of reactions which may cause the precipitation of plugging materials. These included reactions resulting from the presence of alkaline earth metal ions in formation brines and heavy metals in industrial wastes; the oxidation-reduction reaction of hydrogen sulfide with oxidizing agents such as hexavalent chromium compounds; resin-like organic polymers which polymerize to form solids under reservoir temperature and pressure; bacteria and algae growths; and the presence of suspended solids or oil and grease, all of which may physically plug disposal reservoirs.

Laird and Cogbill (2) found permeability reductions on the order of 14% to 70% when two incompatible solutions were simultaneously injected into rock cores. Bernard (3), on the other hand, found no decrease in permeability in similar tests. Hughes (4) pointed out that, although specific chemical reactions may be predicted, the physical effects often are not predictable. For example, an insoluble precipitate formed by incompatible solutions in the rock matrix may (a) cause immediate plugging, (b) be flushed through the rock, or (c) accumulate in the advancing frontal zone with time until plugging eventually occurs. Work presently being conducted (5) on the plugging aspect bears out the likelihood of alternative (c) above. A practical impact of chemical plugging can be seen in oil-field waterflood operations, where measures necessary to prevent plugging by algae, sulfate-reducing bacteria, and insoluble precipitates are taken as a "necessary evil" in the overall operation of an injection facility. These facilities are usually planned for future pressure increases necessary to offset anticipated permeability reduction so that the injection rate can be maintained as desired.

DEEP WELL DISPOSAL IN ALABAMA

Geological Considerations

For the purpose of discussing the geological aspects of deep well disposal in Alabama, the State can be divided into three major areas: 1) Piedmont, 2) Tennessee Valley and Warrior Basin, and 3) Coastal Plain. These areas are shown in Figure 2. Cross-sections of the stratigraphic sequences in each area are shown in Figures 3, 4, and 5.

Piedmont. The scarcity of subsurface information in the Piedmont area prevents accurate predictions of its deep-well disposal potential. Small interior basins on the western side of the Piedmont contain the complete sedimentary sequence of rock formations of Cambrian through Carboniferous. There are some indications of porosity and permeability in the outcropping formations which imply the same properties at depth, but only test drilling can determine if these formations would be suitable for deep-well waste disposal.



FIGURE 2. Index map of Alabama showing three major divisions of geo-physical aspects of deep-well disposal.

Data acquired from wells drilled in Tennessee indicate that porous and permeable zones were found in the Knox dolomite and in a granite wash immediately above the basement rock. The granite wash is considered equivalent to the Rome and/or Weisner in Alabama. Both zones have potential waste disposal capabilities in the Piedmont and in the Tennessee Valley and Warrior Basin to the north and west of the Piedmont.

Tennessee Valley and Warrior Basin. The Black Warrior is a wedge-shaped basin extending across Alabama and Mississippi which contains several thousand feet of clastic and carbonate sediments. The basin is bounded on the north by the Nashville dome, to the east and south by the ridges and thrust faults of the Appalachian front, and extends to the west into sandstones. The various sandstone units comprising the Pottsville section are readily identified on electric logs and appear to be mappable units in the subsurface.

Deep-Well Disposal of Liquid Wastes

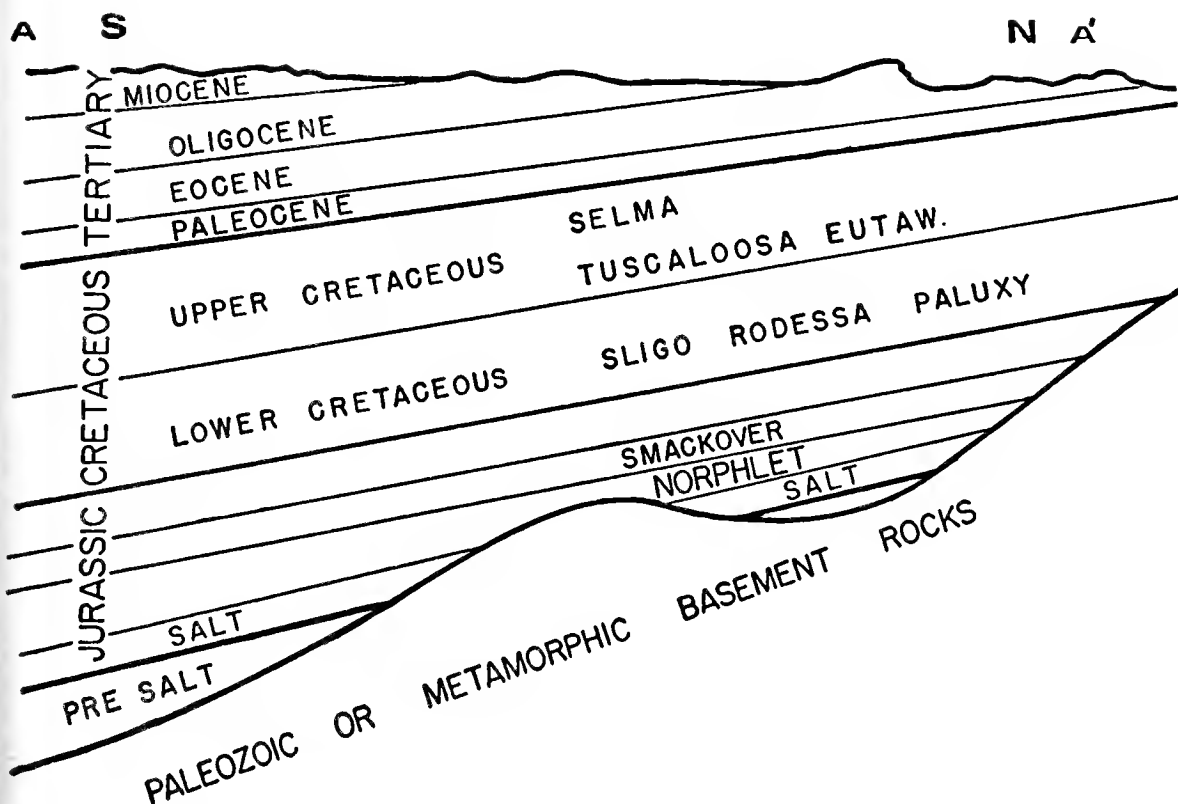


FIGURE 3. Generalized cross-section of south Alabama.

There seems to be a progressive thickening of the Pottsville south-westward across Alabama and a probable thinning of the section along the axis of the Sequatchie anticline (Fig. 6). Examination of the well logs drilled on or near the Wiley dome north of Tuscaloosa indicates the existence of permeability in several sandstone units, varying in thickness up to 345 feet.

Porosity in the basal sandstones appears to be favorable along the margin of the basin. A gamma-gamma density log has indicated a porosity of 15% in the lower Pottsville sands near Tuscaloosa.

The Mississippian Chester series in Northwestern Alabama is composed mostly of oolitic and coarsely crystalline limestones and beds of sandstones. In the southern part of the basin, however, the Chester series is represented by shales, finely crystalline limestones, and shaly sandstones. The Chester series probably thickens from east to west and to the southwest.

Beneath the Chester series lie the carbonates of Lower Mississippian, Silurian, Ordovician, and Cambrian age. A well drilled north of Tuscaloosa encountered a continuous section of limestone and dolomite between 4,000 and 11,000 feet, with only minor amounts of shale and sandstone.

There is a distinct possibility that favorable disposal zones are present in the Knox dolomite and Cambrian sands. Any disposal well

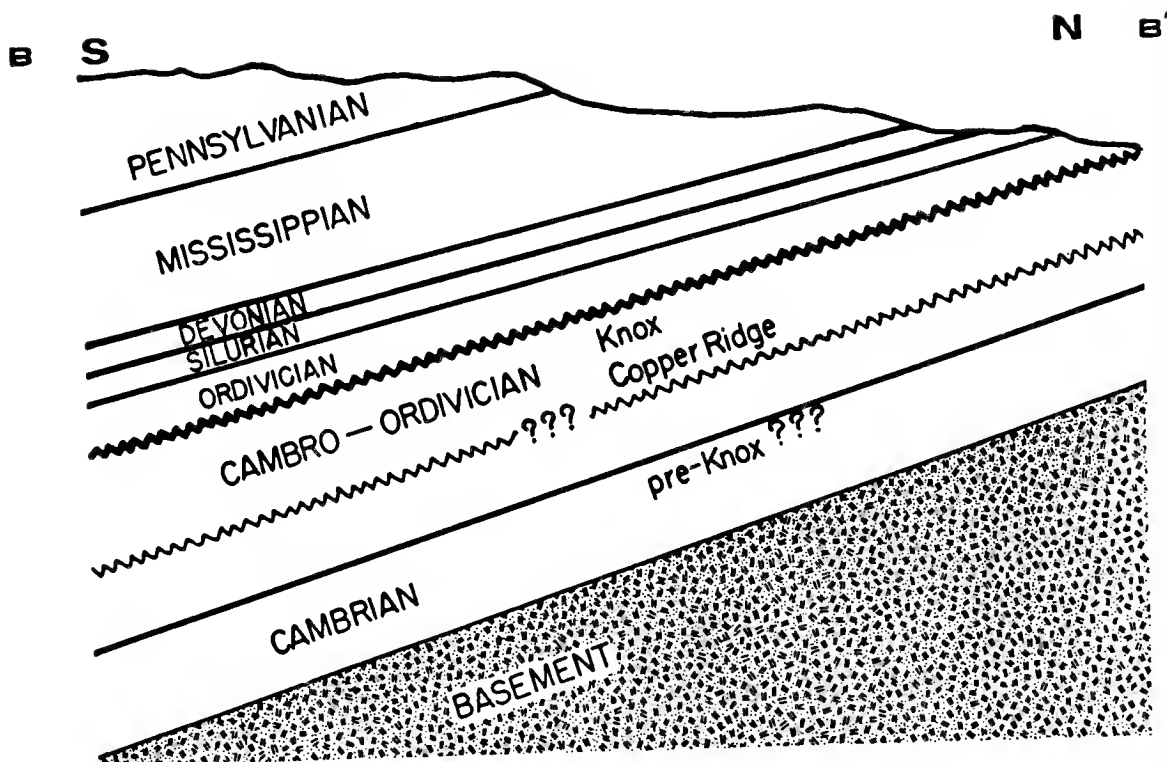


FIGURE 4. Generalized cross-section of north-central Alabama.

drilled in the Basin should be drilled to the Knox porous interval. The basal Pottsville sandstones and Mississippian sandstones and limestones should also be regarded as potential disposal horizons, with the limitation that these formations sometimes contain fresh water in areas of North Alabama.

Coastal Plain. The Coastal Plain Province is considered the more important ground-water-producing area in Alabama. The sedimentary origin of all aquifers and the abundant rainfall in the outcrop area provide unusual groundwater supplies.

Formations ranging in age from Recent to Upper Cretaceous outcrop in the Coastal Plain Province. Formations from Lower Cretaceous to Jurassic in age are in the subcrop. Stratigraphic and structural strike are regionally northwest-southeast. Formation dip is southwesterly at a rate of approximately 50 feet per mile except where disrupted by local structural features.

A distinguishing characteristic of Coastal Plain geology is the prominence of structural features in the area. Prominent structural features within the salt basin in Southwest Alabama are the Hatchetigbee Anticline, the Jackson Fault-Klepac Dome, the Mobile Graben, and the Gilbertown, Coffeerville-West Bend, Walker Springs, Pollard, and Bethal Fault zones. Other prominent structures are the domal anticlines near Chatom, Citronelle, South Carlton, and the piercement salt dome at McIntosh (Figure 7).

C NW

SE C'

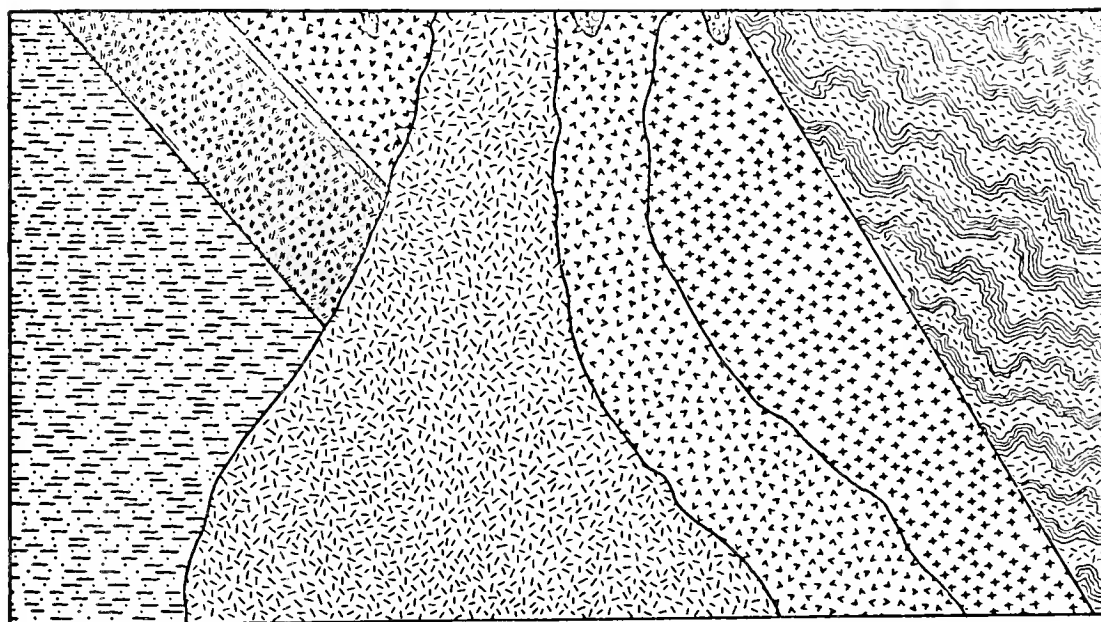


FIGURE 5. Generalized cross-section of east-central Alabama.

The Hatchetigbee Formation is the oldest formation exposed at the surface in the breach crest of the anticline. A structure map drawn on the top of the Selma Group shows approximately 500 feet of closure on the eastern end of the anticline. About 25 oil wells have been drilled on this structure since 1902, but no commercial indications have been found. The Hatchetigbee Anticline, if found to be barren of hydrocarbons and commercial brines, could be used as a closed reservoir for the injection of liquid wastes.

The Jackson Fault and Klepac Dome are found on the southeastern end of the Hatchetigbee Anticline. The Jackson Fault is about 35 miles long, having a northerly trend extending to a point north of Jackson, Alabama. It is downthrown to the west, and exhibits about 5,000 feet of throw at a depth of 2,450 feet. The large amount of displacement probably results from salt movement.

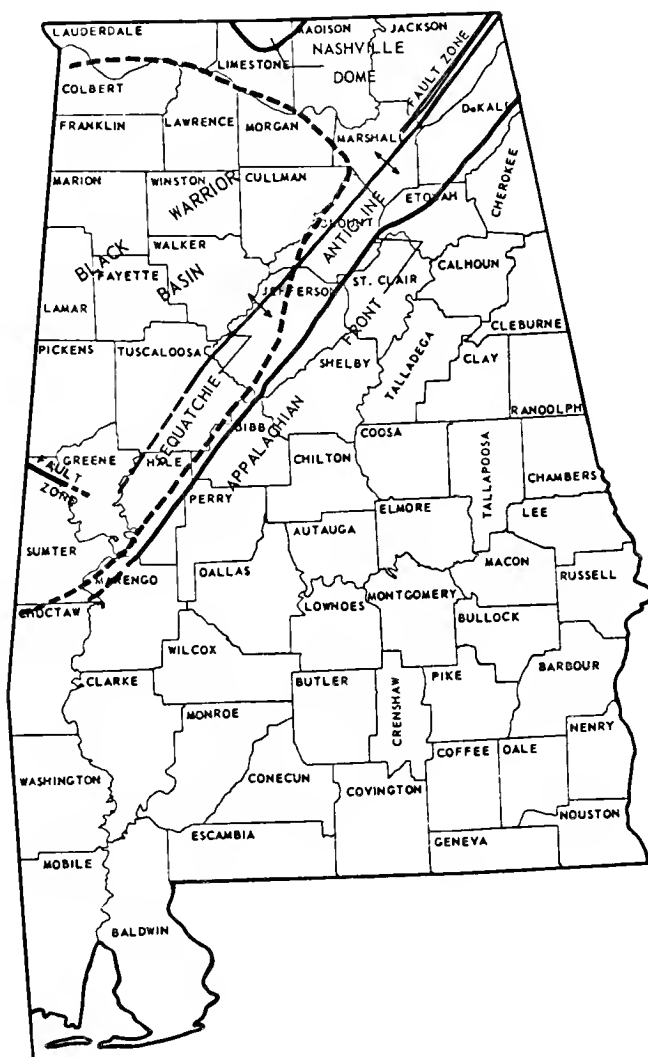


FIGURE 6. Major structural features in northwestern Alabama.

The Klepac Dome is a high-relief domal structure with a deep non-piercing salt dome at its core. It is bounded on the west by the Jackson Fault. Upper Cretaceous and Tertiary sediments are thin across the dome, but thicken considerably on the downthrown side of the Jackson Fault (Figure 8). The thickness of the Selma Group, for example is 2,100 feet on the downthrown side, nearly twice its normal thickness in the area. This thickening, at first glance, would indicate that disposal of liquid wastes would be favorable in this area. Such disposal, however, should be avoided in the immediate area of the Jackson Fault because of possible contamination of the liquid waste with fresh water aquifers by migration through the fault plane.

A complex north-south fault system known as the Mobile Graben extends from Jackson, Alabama south to Mobile Bay. The Jackson Fault is the northernmost fault on the east flank of the graben system. The major

Deep-Well Disposal of Liquid Wastes

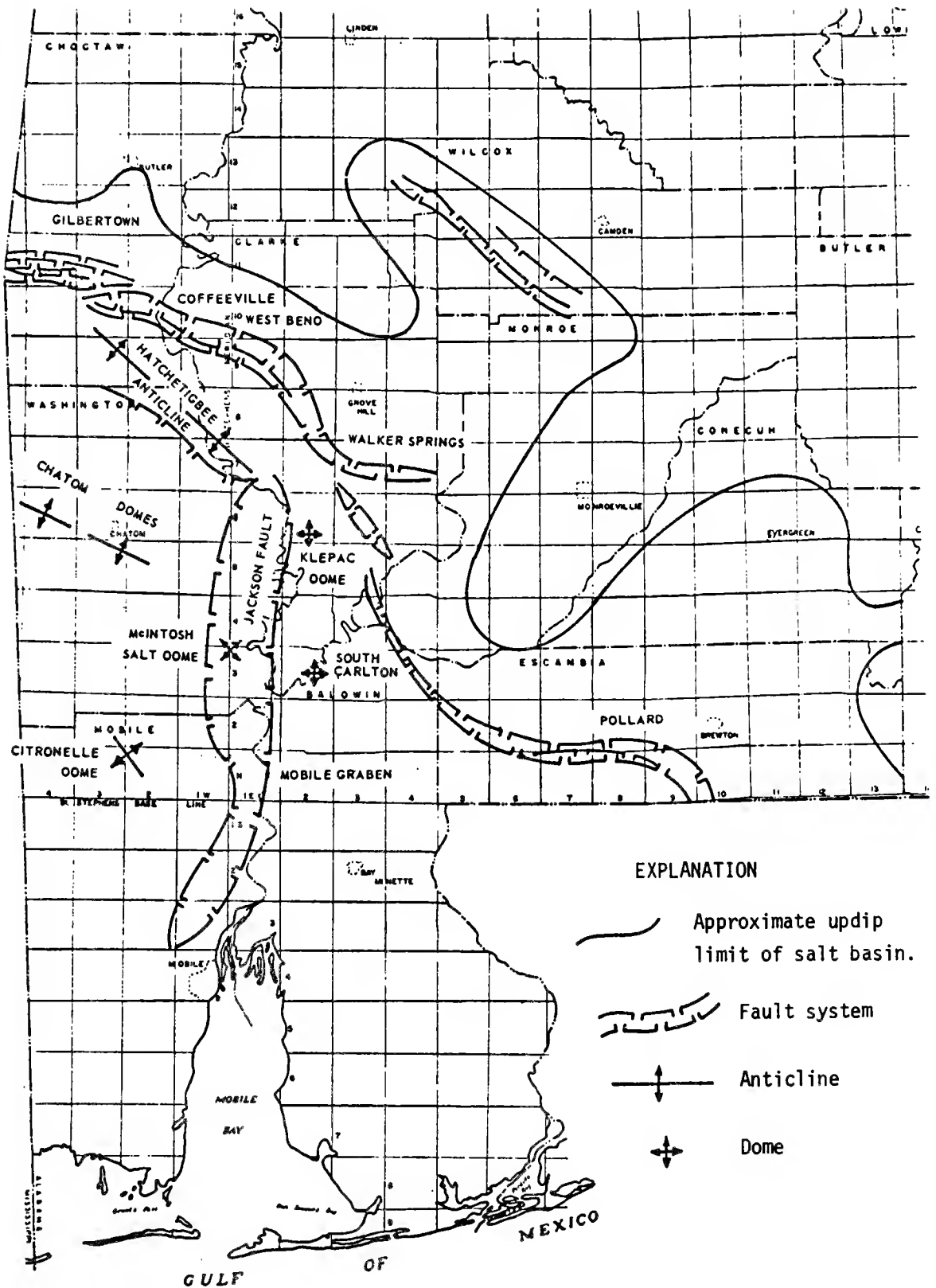


FIGURE 7. Location of prominent structural features in southwest Alabama.

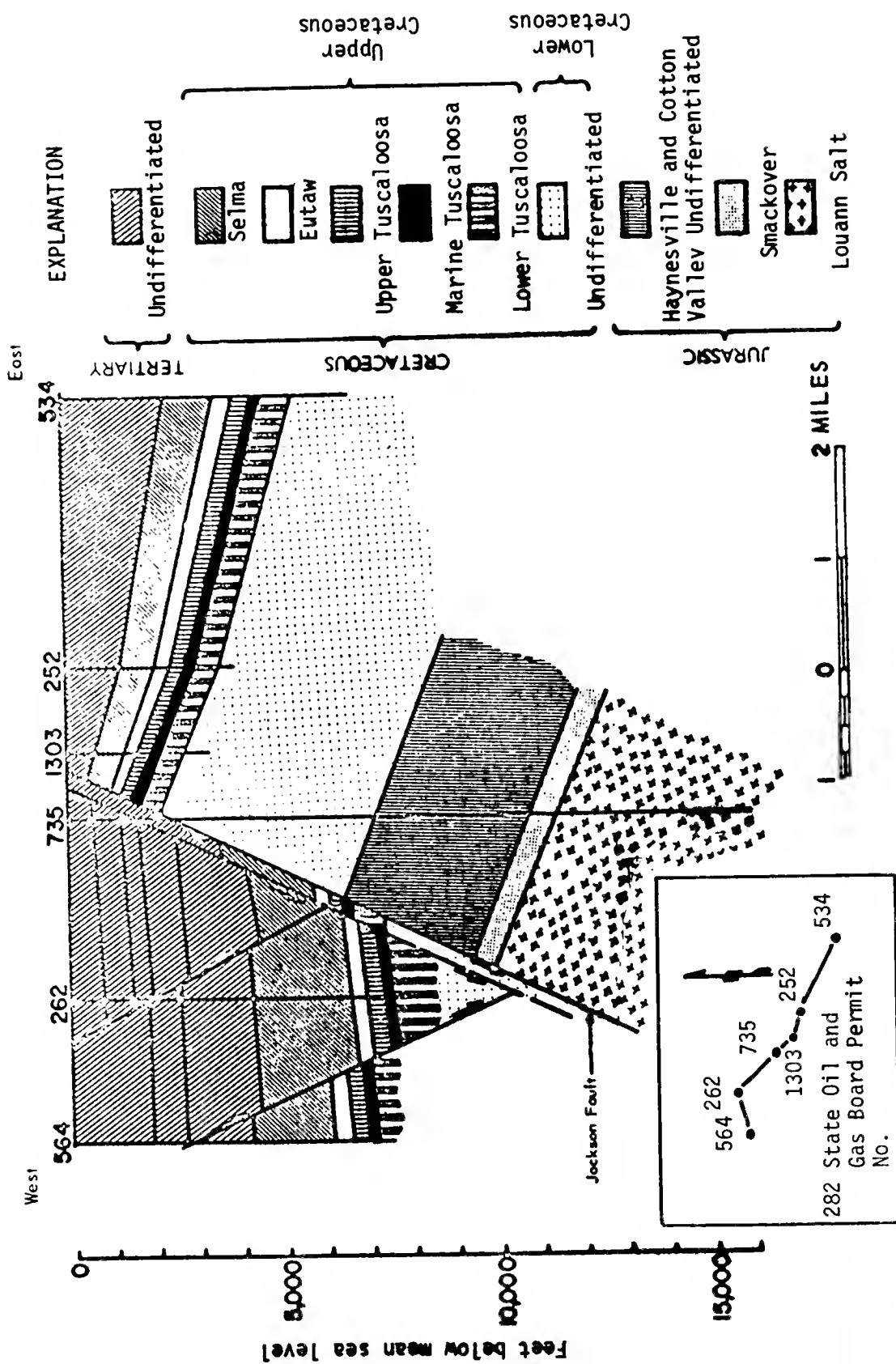


FIGURE 8. East-west cross-section of Klepac dome.

Deep-Well Disposal of Liquid Wastes

fault comprising the west flank of the graben opposite the Jackson Fault has never been penetrated, but its location has been postulated by subsurface data from nearby wells. Successful subsurface waste disposal systems are already operating in this area and future projects are feasible; but proposed injection wells must be properly located with respect to known faulting.

The peripheral faults (Gilbertown, Coffeetown-West Bend, Walker Springs, Pollard, and Bethal) are similar to and probably constitute an extension of fault zones through Mississippi, Arkansas, and into Texas. These faults probably represent the periphery of the salt basin. Unlike areas further south, these faults can be detected on the surface, where movements have been so recent that the grabens are topographic lows. These peripheral graben-type fault systems extending across Southwest Alabama have attracted most of the oil and gas exploration activity in the State during recent years. Already, 7 of Alabama's 12 oil fields occur within and are directly related to this fault system. The presence of extensive faulting would be detrimental to large waste disposal systems in this area since communication with fresh-water sources could possibly result.

The Citronelle Oil Field in Mobile County is situated on a slightly elongated, northwestward-trending domal anticline which has about 400 feet of vertical closure on the Lower Tuscaloosa mapping horizon. This field has 410 wells on a surface area of approximately 6 square miles. A gravity "low" over the anticline probably indicates the presence of a nonpiercement salt dome. The Citronelle dome has an influence on the surface topography, and the area displays a classic example of radial surface drainage.

The Citronelle dome would undoubtedly be an excellent closed reservoir for the injection of liquid wastes, since water injection for secondary recovery of oil has been very successful in this area. At the present time, however, the protection and conservation of the hydrocarbons would deter indiscriminate liquid waste injection in the Citronelle dome.

A low relief domal anticline controls oil production in the South Carlton Field in Clarke and Baldwin Counties. The structure exhibits a maximum of 40 feet of vertical closure on the top of the Lower Tuscaloosa mapping horizon. Salt flow from the nearby Jackson Fault may be associated with the domal structure at South Carlton. Some minor faulting is present at South Carlton, and the effects of these faults on the production of oil or the injection of waste liquids is not known. However, it may be inferred that this area would be suitable for waste liquid injection because of the adequacy of porosity, permeability, and subsurface control resulting from oil production experience.

A major structural feature of south Alabama is the McIntosh Salt Dome in Washington County. The dome pierces Miocene sediments within 410 feet of the surface and is about 1 mile in diameter. A rim syncline and complex peripheral faults are associated with this structure. Wells drilled in this area have all encountered abnormally thick formations. The subsurface waste disposal potential of this area should be favorable.

Deep nonpiercement salt movement resulted in structures of major proportions near Chatom in Washington County. These structures are referred to as the Chatom Domes. They should provide potential reservoirs for liquid waste disposal, since they are closed and have no major faulting associated with them.

The influence of the basement structure must be considered in areas of south Alabama. These features probably have a northeast-southwest alignment coinciding with the Appalachian system. The ridges and valleys of the Appalachian system which project into the subsurface of Southwest Alabama may affect the accumulation of hydrocarbons in that area. The interval in the subsurface reflecting the unconformity between the coastal-plain sediments and the basement rock should be an excellent zone for the injection of liquid waste, particularly where this zone could be penetrated at depths less than 6,000 feet.

Figure 9 represents the minimum depth to the first nonpotable water sand in the Coastal Plains. This should be regarded as a disposal guideline only, and greater depths should possibly be considered in protecting fresh water resources. Porous and permeable sandstone formations are available for subsurface disposal below 3,000 feet in depth, and meet the necessary physical requirements to render them suitable for long-term injection service.

The structure map on top of the Selma Chalk (Figure 10) provides a useful guide for selecting a suitable disposal formation. Although disposal prospects exist above the Chalk, the presence of this relatively thick, impermeable formation should provide added insurance for preventing the upward migration of toxic liquid wastes disposed below the Chalk. Formations below the Chalk are predominantly sandstone and are suitable for disposal. Whenever possible, waste liquid disposal reservoirs should be selected below the Selma Chalk in southwest Alabama.

Past Disposal Practice in Alabama

The 1964 ruling by the Alabama State Oil and Gas Board prohibiting surface brine disposal pits resulted in the drilling of 4 wells specifically for brine disposal. In addition, the secondary recovery program at Citronelle presently utilizes four basic systems to encompass the production of oil, production and injection of fresh water into the oil reservoir for repressurization, and the injection of produced brine into a disposal zone:

(a) Production of fresh water from Miocene sands at 600-800 feet depth.

(b) Injection of fresh water into the oil reservoir from which formation fluids are being taken. The depth of the formation at Citronelle distinguishes the project as the world's deepest secondary recovery in present operation. To date, about 3 billion gallons of fresh water have been injected into the Lower Cretaceous oil reservoir at 10,500 feet depth through 51 injection wells. Present injection pressure is 3,000 psi to deliver about 40 gallons per minute in each well.

Deep-Well Disposal of Liquid Wastes

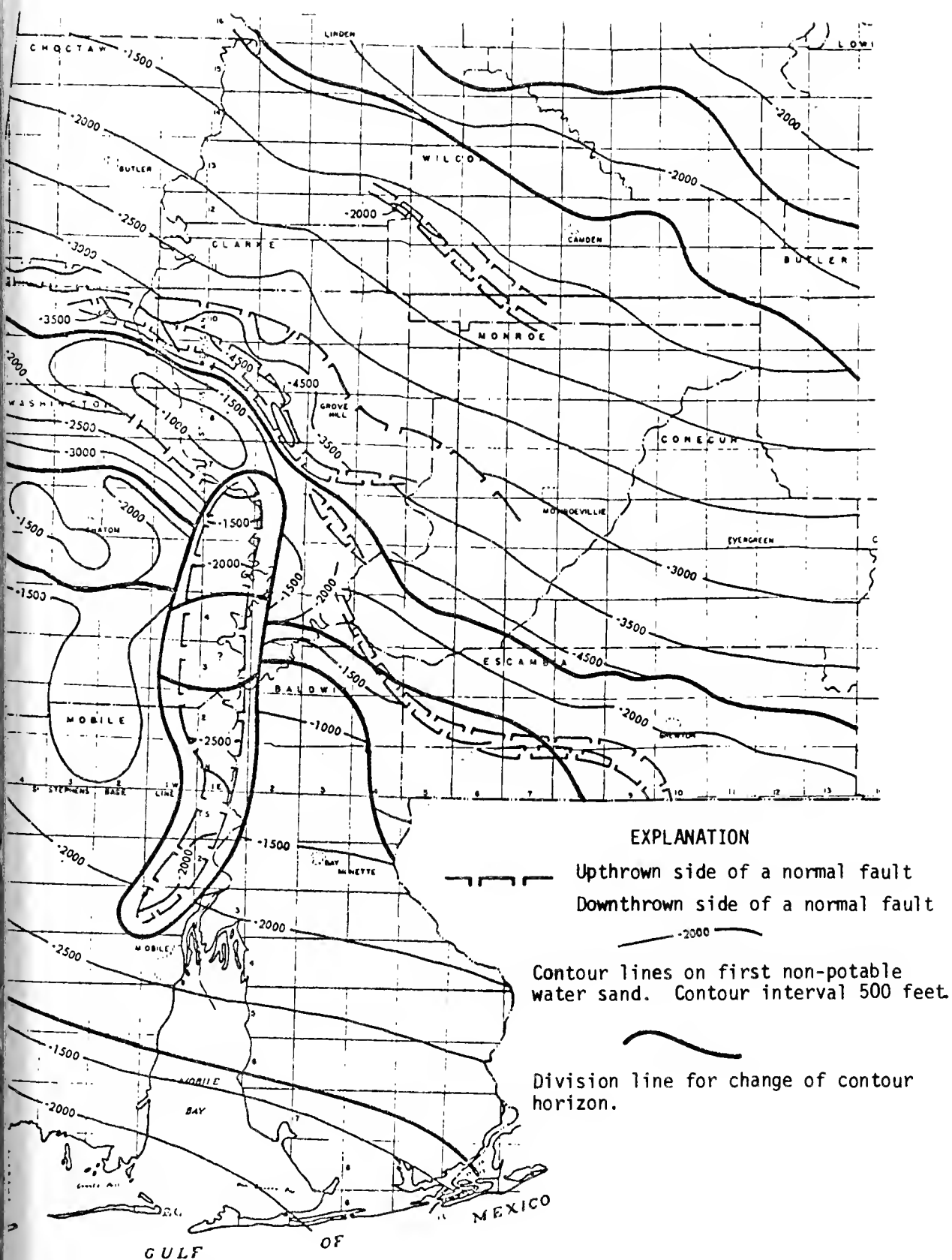


FIGURE 9. Minimum depth of first non-potable water-bearing sand in the coastal plain.

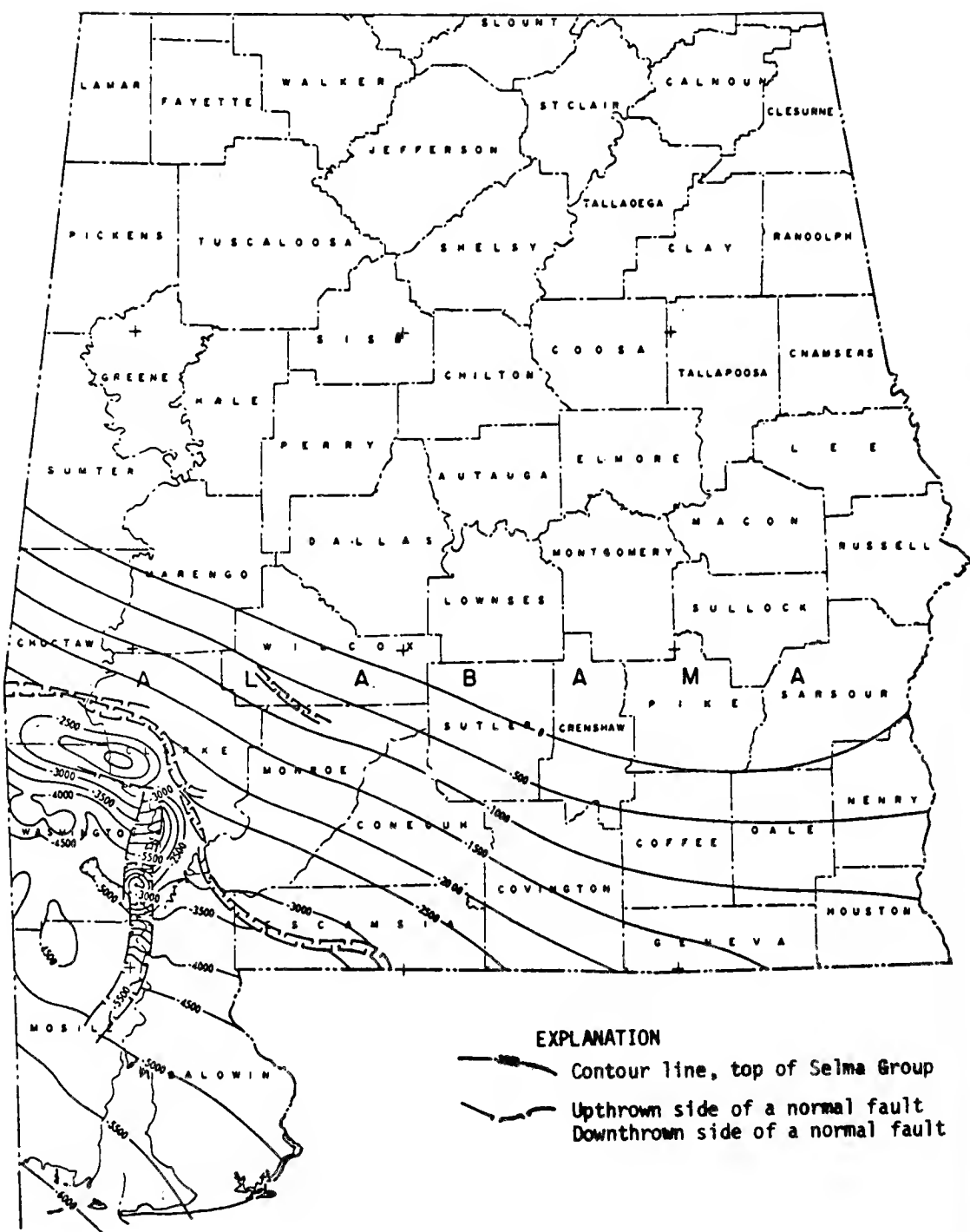


FIGURE 10. Structure map on top of Selma Group in southwest Alabama.

Deep-Well Disposal of Liquid Wastes

(c) Injection of produced brine into a reservoir from which formation brine was previously taken. Some 1 billion gallons of brine were produced from this Upper Cretaceous reservoir (7,000 feet in depth) and used for the waterflood. This practice was discontinued in lieu of fresh water usage and the water supply wells were recompleted as disposal wells. Two wells are disposing 240 gallons per minute at 300 psi pressure.

(d) Injection of produced brine into a reservoir from which formation fluids have not been taken. An Eocene sand at 2,000 feet depth is being used to dispose of brine at a rate of 60 gallons per minute and a pressure of 250 psi.

In addition to brine disposal in petroleum operations, a total of 5 wells have been drilled in Alabama specifically for the disposal of industrial liquid wastes. These wells, along with pertinent data for each, are listed in Table 1 and illustrated in Figure 11.

SUMMARY

Subsurface liquid waste disposal in certain areas of Alabama is an established fact. The vast amount of subsurface data obtained by drilling oil and gas wells indicate that several potential disposal horizons exist in Southwest Alabama. In this area, geologic formations of Tertiary age between 1,200 and 4,500 feet in depth have the capacity to accommodate large volumes of liquids with no danger of contaminating fresh water resources if care is taken to avoid structural abnormalities. A zone of impermeable material above 1,200 feet will prevent vertical migration of waste liquids in this area. Sandstone reservoirs of Upper Cretaceous age from 6,000 to 8,000 feet provide an unlimited capacity for liquid disposal in this part of Alabama.

Depleted oil reservoirs may offer a future disposal opportunity. They can be readily evaluated as to capacity and receptivity, and the needed barriers to upward migration can usually be found in any sand-shale cross-section typical of this area. As an example of potential capacity using oil productivity figures, the voidage to date in the Citronelle field would accommodate the injection of 200,000 gallons of waste per day for 50 years.

In the northwestern part of the Coastal Plain, the presence of a thick sandstone below the Smackover limestone offers an attractive prospect for waste disposal. This formation, referred to as the Norphlet sand, has been noted to be 400 feet thick at 7,000 feet depth in Wilcox County.

The Warrior Basin sandstones of Pottsville age have thicknesses from 400 to 500 feet, and appear to have adequate porosity and permeability for waste disposal in some areas, although they are "tight" in most instances. Choosing a disposal formation at the present time would be by "cut and try" as the well is being drilled.

In North Alabama, the Knox dolomite develops a porous zone at 2,500 feet depth which is suitable for waste injection. This zone is extensive and may be present over much of the Tennessee Valley-Warrior Basin area from depths of 2,500 feet up to 12,000 feet.

TABLE 1. - Disposal Wells in Alabama

Well No.	Company Name	Total Depth	Depth of Disposal Zone	Disposal Formation	Present Status	Base of Fresh Water	Thickness of Disposal Zone	Depth of Surface Casing
1	Stauffer Mobile Co.	4300	3400	Wilcox Group Nanafalia Formation	In operation	700	80	1238
2	Ciba-Geigy Washington Co.	7513	3800	Wilcox Group	Awaiting installation of surface equipment	600	150	1050
3	Ciba-Geigy Washington Co.	2510	2000	Clairborne Group	Awaiting installation of surface equipment	600	300	1017
4	Reichhold Tuscaloosa Co.	8097	6620	Silurian-Undifferentiated	Awaiting installation of surface equipment	700 ¹	50	1220
			7036	Ordovician-Undifferentiated	Awaiting installation of surface equipment			
5	U. S. Steel Jefferson Co.	6072	4415	Red Mountain Formation	Awaiting installation of surface equipment	700 ¹	215	1110

¹ Approximate

Deep-Well Disposal of Liquid Wastes

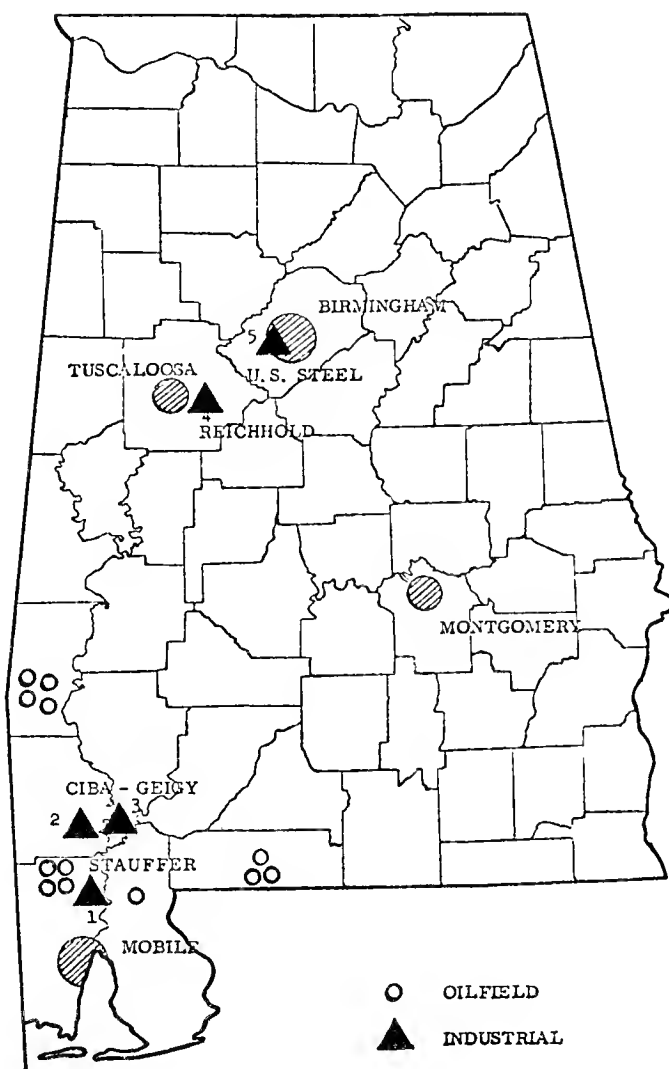


FIGURE 11. Disposal wells in Alabama.

The Piedmont area of Alabama is essentially an unknown quantity with regard to deep-well waste injection. The aspects of disposal from geologic considerations appear to be poor, since crystalline basement-type rocks and metamorphic rocks comprise the surface and shallow subsurface in the area. Until more subsurface data are taken in this area, it offers the most speculative disposal area in Alabama.

Legal implications of waste disposal in underground reservoirs have not been fully explored in most states, including Alabama. Statutes in Alabama are totally silent in this respect. So far, precedent established by the petroleum industry regarding law and mineral ownership of subsurface rights has been followed. Until definitions of legal responsibility are further clarified, the disposal of liquid wastes in underground reservoirs should be undertaken only after a competent showing can be made of adequate capacity, receptivity, confinement of the disposal formation, and positive control of the flow stream.

ACKNOWLEDGEMENTS

The work done by the Natural Resources Center at the University of Alabama and the Geological Survey of Alabama on Project B-019-ALA, Office of Water Resources Research, Department of the Interior, comprised the background for this paper. The author served as project co-director during the investigation, and wishes to acknowledge the efforts of Dr. David M. Grubbs of the University of Alabama and Mr. William E. Tucker, formerly of the Geological Survey of Alabama, for their contributions as co-directors. The subsurface maps used as illustrations in this paper were prepared by the Geological Survey of Alabama staff.

REFERENCES

1. Selm, R. F., and B. T. Hulse. Deep well disposal of industrial wastes. Chem. Engr. Prog., Vol. 56, n. 5, p. 138, 1960.
2. Laird, R. W., and A. F. Cogbill. Incompatible waters can plug oil sands. World Oil, Vol. 146, n. 6, pp. 188-190, May, 1958.
3. Bernard, G. B. Effect of relations between interstitial and injected waters on permeability of rocks. Producers Monthly, Vol. 20, n. 2, pp. 26-32, December, 1955.
4. Hughes, T. H. Conservation of fresh-water resources by deep-well disposal of liquid wastes; Part I. Chemical reactions between acid industrial wastes, formation waters, and minerals in salaquifers of Alabama. Final Report, O.W.R.R. B-019-Ala, p. 2, May, 1970.
5. Grubbs, D. M., C. D. Haynes, and T. H. Hughes. Compatibility of subsurface reservoirs with injected liquid wastes. Final Report, O.W.R.R. B-030-Ala, Natural Resources Center, University of Alabama, Report 721 (in press).

An Early Attempt at Wage and Price Controls

AN EARLY ATTEMPT AT WAGE AND PRICE CONTROLS: DIOCLETIAN'S EDICT OF 301 A.D.

James W. Park
Department of Economics
University of Alabama, University

President Nixon's recent effort to curb inflation through wage and price controls seems to be from the same mold as Diocletian's Edict of 301 A.D. which established wage and price controls in the Roman Empire. A study of this Edict may help us now to achieve a better understanding of modern inflationary conditions and attempts to dampen inflation.

The Roman monetary system was based mainly on three types of coins: the gold aureus, the silver denarius, and the bronze *as*. Massive issues of bronze *asses* and silver *denarii* were begun in the middle of the second century B.C.¹ The gold coins were issued primarily in the Imperial period. These coins were probably first issued solely for the state to make its payments--with no thought of providing a medium of exchange for the general population.²

Generally speaking, from the time of the First Punic War to the reign of the Emperor Nero, Roman coins had a relatively stable value. Inflation was mild (except for short periods) and not a disturbing factor in the Empire's economy. Nero, however, started a series of devaluations of the coinage that lasted through the fall of the Empire. A reduction of the precious metal content of coins in the Roman Empire meant that the coins eventually became worth less in terms of goods and services; therefore, prices of the goods and services rose. This process can be defined as monetary inflation. It should be pointed out that because of the lack of scientific knowledge among the general population, it was difficult for the average citizen to detect a small reduction in the precious metal content of a coin; therefore, the emperors could have the coins melted down, and with additional alloy could produce a larger amount of money with which the government could make its payments. In fact, Nero and succeeding emperors did make a profit by recoinning the money as the following illustrations show.

At the beginning of Nero's reign, the silver denarius contained about 96 percent silver; by 301 A.D., it contained about 3 percent silver.³ The denarius had by this time become mainly a copper coin that had been dipped in tin. The gold aureus fared somewhat better. At the time of Nero, it contained 112-117 grains of gold; two centuries later

¹Michael Crawford, "Money and Exchange in the Roman World," *The Journal of Roman Studies*, LX (1970), 48.

²*Ibid.*, p. 46.

³L. C. West, *Gold and Silver Coin Standards in the Roman Empire* (New York: The American Numismatic Society, 1941), pp. 24-26.

in the reign of Elagabalus it still contained 98 grains, but the emperors gradually ceased to mint the gold coins because they did not circulate anyway--they were too valuable to do so.⁴ The bronze coins eventually became worthless and were used as token money.

For the part of the Roman Empire that is not Italy, there is little evidence of inflation until around 300 A.D. The financial documents written on papyrus did not survive time and the weather. However, evidence of prices may be obtained from Roman Egypt where the warm dry climate preserved many documents. Egypt, although a part of the Empire, had its own monetary system until 297 A.D. Its coinage was based on the drachma that circulated at a ratio of 4 to 1 with the Roman denarii.⁵

It is generally believed that the price level in Egypt reflected Mediterranean prices of the same period. Following are examples of Egyptian prices. The price of wheat under Augustus Caesar was 2-4 drachmae per artaba (about 1.10 bu.). In 45 A.D. wheat was priced at 4-8 drachmae per artaba. In 162 A.D. it was priced at 8 drachmae; and in 250 A.D. wheat sold for 12-16 drachmae per artaba.⁶ It can be inferred then that prior to 250 A.D. inflation in the Roman Empire was mainly of the creeping type. After this time, though, the rate of inflation increased tremendously.

In 294 A.D. wheat sold for 232 drachmae per artaba. By 301 A.D. this same amount of wheat was selling for 1,333 drachmae. In 314 A.D. the price had increased to 10,000 drachmae, and by 334 A.D. the price was 2,000,000 drachmae per artaba. Converted to denarii, it would have taken 16 tons of coins to buy 50 pounds of wheat. What probably happened was that the value of the drachmae coins was raised to compensate for the increase in prices.⁷

There is also evidence that the price of animals increased greatly. For example, in 217 A.D. a donkey cost about 400 drachmae, and by 287 A.D. the price had risen to about 3,800 drachmae.⁸

By the time of the reign of the Emperor Diocletian, trade and commerce in the Roman Empire had become almost impossible except by barter. In fact, the rapid inflation throughout the Empire almost caused a collapse of the entire Empire. Diocletian tried to reduce the inflation. First, he sought to reform the monetary system by coining a high silver content denarius. However, silver was extremely scarce, and not enough

⁴*Ibid.*, pp. 16-18.

⁵Allan Chester Johnson, *Egypt and the Roman Empire* (Ann Arbor: University of Michigan Press, 1951), p. 15.

⁶*Ibid.*, p. 27.

⁷*Ibid.*

⁸*Ibid.*

An Early Attempt at Wage and Price Controls

of it could be obtained to put many silver coins into circulation. Next, a reform of the bronze coins was attempted. The bronze coins were overvalued, and they drove the gold and silver coins out of circulation.⁹

During the next few years, there was wild inflation and much monetary confusion. Eventually, Diocletian issued an edict in 301 A.D. that set maximum prices for over 900 goods, 130 grades of labor, and for a large number of freight rates. This edict was carved in stone and displayed in the larger cities. For example, copies in stone have been discovered in Aphrodisias in Caria, in Ptolemais in Cyrenaica, in Tiberius, in Delphi, and in other locations. The edict contains a preamble and then a listing of prices of goods, services, and freight rates.¹⁰

The preamble states that now that peace has returned to the Empire the resulting prosperity must be guarded by a regulation of prices. It also cites a need to curb the activities of speculators. In addition, it points out that inflation has become so embedded that abundant supplies of goods do not bring prices down. It states: "For who is so insensitive and so devoid of human feeling that he cannot know, or rather, has not perceived, that in the commerce carried on in the markets or involved in the daily life of cities immoderate prices are so widespread that the uncurbed passion for gain is lessened neither by abundant supplies nor by fruitful years" Furthermore, the preamble draws attention to the fact that the government is having so much difficulty paying the armies when prices are rising so rapidly that national defense has been jeopardized.

The edict is careful to state that it does not establish normal prices but sets only maximum prices. Citizens are free to charge less. Finally, the preamble states that violators will be subject to a capital penalty, and that capital punishment is also reserved for those who withdraw goods from the markets because they feel that the maximum prices are too low. The following list shows the items covered by the edict.¹¹

<i>Goods</i>	<i>Number</i>
Foods	222
Hides and leather	87
Timber and wood products	94
Wicker and grass products	32
Textiles and clothing	385
Cosmetics, ointments, incense	53
Precious metals	17
Miscellaneous	31

⁹H. Michell, "The Edict of Diocletian: A Study of Price Fixing in the Roman Empire," *The Canadian Journal of Economics and Political Science*, XIII (February, 1947), 5.

¹⁰Unless otherwise indicated, all further references to the Edict of 301 are from Tenny Frank, *An Economic Survey of Ancient Rome: Rome and Italy of the Empire*, V (Baltimore: The Johns Hopkins Press, 1940), pp. 310-421.

¹¹Michell, *Op. Cit.*, p. 6.

Journal of the Alabama Academy of Science

<i>Wages</i>	<i>Number</i>
General, skilled, and unskilled	76
Silk workers and embroiderers	13
Wool weavers	6
Fullers	26

Perhaps it would be helpful at this point to list a few of the prices, wages, and freight rates stated in the edict.¹²

<i>Goods</i>	<i>Price</i>
1 castrensis modius of wheat	100 denarii
1 castrensis modius of rye	60 "
1 castrensis modius of oats	30 "
1 Italian pint of Sabine wine	30 "
1 Italian pint of olive oil, ordinary	12 "
1 Italian pound of beef	8 "
1 pair of chickens	60 "
1 Italian pound of salted fish	6 "

The Edict of 301 regulated wages to a high degree. An unskilled laborer could make no more than 25 denarii per day, and a skilled laborer could earn no more than 50 denarii. A wall painter could receive 75 denarii per day, and a figure painter could receive 150 denarii. A shipwright on an ocean-going vessel could receive as much as 60 denarii per diem, while a shipwright on a river-going vessel could receive only 50 denarii. The lowly clothes guard could receive only 2 denarii per bather. Those with the highest maximum amounts were the workers of precious metals. Gold cutters could receive 3,000 denarii per pound, and gold spinners could receive 2,500 denarii per ounce.¹³

Diocletian also provided maximum freight rates for inter-Empire trade. The maximum rate that could be charged for shipping a castrensis modius of wheat (half bushel) from Alexandria to Rome was 16 denarii. It is interesting to note that the rates for items carried for the government were about half the ordinary commercial rate. From Alexandria, there were rates for about ten destinations; from Africa, there were rates for 13 destinations; and from Nicomedia, there were rates for some 30 destinations.¹⁴

Within five years, the Edict of 301 A.D. was a complete failure. The prices listed were in terms of the denarii which had been tariffed at 50,000 to the pound of gold. Two years later, the government recognized the impossibility of maintaining this rate and, therefore, raised the official rate to 60,000. Prices rose rapidly. Then the weight of the denarius was lowered.

¹²Frank, *Loc. Cit.*

¹³Michell, *Op. Cit.*, p. 6.

¹⁴*Ibid.*, p. 7.

An Early Attempt at Wage and Price Controls

This caused a further decline in the purchasing power of these coins. By 305 A.D. the price of gold had risen to 120,000 denarii per pound. In 324 A.D. the rate was 172,800. Late in the fourth century, the figure of 473,000 was reached. In the middle of the fifth century, the rate was 504,000 denarii to the pound of gold. By this time, it was hopeless to try to have a mint ratio between a pound of gold and the denarius.¹⁵

Attempts have been made to explain the reasons for the failure of the edict. One scholar feels that the failure was due to the fact that the price structure was too rigid, and that differences between wholesale and retail prices were not allowed.¹⁶

Professor Michell believes the failure occurred because the stock of precious metals had been too small to make the new standard effective. The mines known to the Romans were exhausted by about 250 A.D.

The inflation following the Edict of 301 A.D. was compounded by the fact that Diocletian ruled that taxes should be paid in kind. A reform in taxation was certainly necessary by Diocletian's time. There was an increase in the size of the army and an increased number of battles. With the concurrent decline in the value of the money, the treasury could not meet the payments. The situation was further complicated by Diocletian's building policy. He constructed public buildings, palaces, basilicas, baths, libraries, and a circus. In addition, a large number of arches were constructed.¹⁸

Diocletian's ruling that taxes should be paid in kind ran counter to his policy of controlling inflation. Since most of the taxes were paid in kind, the government could not tax away the ever increasing supply of money.

Diocletian abdicated in 305 A.D. without winning the battle against inflation. Some of the succeeding emperors made heroic efforts to control inflation, but they never were successful except for short periods of time. The fires of inflation were still raging as the Roman Empire collapsed.

It is interesting to compare inflation in the Roman Empire with the eras of hyperinflation of more modern times--the main difference is the Roman government issued near-worthless metal coins instead of near-worthless paper currency. As pointed out earlier, the Roman emperors created monetary inflation by calling in coins, melting them down, and recoinning them with a lower precious metal content. Today, modern governments rely upon an

¹⁵*Ibid.*, p. 11.

¹⁶Frank, *Op. Cit.*, p. 299.

¹⁷Michell, *Op. Cit.*, pp. 11-12.

¹⁸H. M. D. Parker, *A History of the Roman World from A.D. 138 to 337* (New York: Barnes & Noble, Inc., 1963), p. 281.

indirect approach to putting additional money into circulation.¹⁹ They either run the printing presses or sell government bonds to their central bank which then allows the expansion of currency and demand deposits based upon the bonds as a reserve. Just as there was no effective way to keep the Roman emperors from debauching the coinage, there are really no effective brakes on the amount of money that modern central banks can put into circulation. Today, the temptation to stimulate domestic economic activity through increasing the money supply is great. Consequently, wage and price controls are called upon to curb inflation. At the present time, President Nixon's wage and price controls do not seem to be more effective than Diocletian's.

¹⁹It should be remembered that in most countries today money is defined as coins, paper currency, and demand deposits at commercial banks. Coins make up only a minor part of the total money supply.

Economics in the Social Sciences Curriculum

ECONOMICS IN THE SOCIAL SCIENCES CURRICULUM

Kenneth E. Van Sise
Business and Economic Education
Samford University, Birmingham, Alabama

The United States Economy has been plagued with problems of war, inflation, unemployment, international imbalance and many social complexities which characterize a time when a higher degree of economic education becomes more and more necessary to the betterment of our society. These major problems are centered around the political, social and economic forces. One has only to pick up a daily newspaper to find that considerable space is being devoted to matters of economic content signifying the importance that economics plays in our daily lives.

It would seem to me that it is no longer sufficient to have teachers in the classrooms deal primarily with the practical problems of everyday living, since our society is dynamic and we must come to grips with the problems that have grown in complexity since the early part of the decade of the 60's and will continue with us throughout the decade of the 70's. The curriculum in the Social Sciences must be so designed that it will equip students to deal intelligently with the problems that their generation will be called upon to solve.

Studies conducted by Centers of Business and Economic Education stress the importance of upgrading methods and materials to have a constituency that is more informed on economic matters. Despite the growing importance of economics in the face of an abundance of information that is now available, economic illiteracy still prevails. It becomes necessary to move in the direction of curriculum development that will introduce to each student the essential economic principles of dynamic market economy.

Should the Development of Economic Literacy be Left to Professional Economists?

One can look to the tremendous developments that have taken place in economic education since 1949 when the Joint Council on Economic Education of New York was founded. There has been vigorous growth of the Joint Council on Economic Education's activities at the national and local levels, and today there are 80 Centers for Business and Economic Education throughout the country; presently in Alabama alone, there are three Centers for Business and Economic Education--the first starting at Samford University in 1968, followed by the University of Alabama at Tuscaloosa and the University of South Alabama.

There has been strong support for economic education from the independent businessmen's organizations (such as the Young President's Organization), and there has been a practical implementation of curriculum changes by imaginative secondary and elementary school teachers here and there across the country. As a result of the activities of the past 25 years, we have found that professional educators and businessmen and teachers at the social science level have stepped in to make economic

education more palatable and, at times, less rigorous than the professional economist would make it. The bringing together of the professional economist, the educator, the businessman and interested groups has generated increased activity and growth in economic education and will produce a better informed citizenry on economic problems.

What are Some Problems of the Social Sciences in Economic Education?

To answer this question I shall have to draw a detailed picture of economic education in Alabama by investigating 7 topics: (1) Teacher Background in Economics, (2) In-Service Experiences of Teachers, (3) Resources Used in the Classrooms, (4) Teaching Methods, (5) Testing of Economic Understanding, (6) Teachers' Feelings Regarding Need for Improvement of Economic Education, (7) Extent of Economic Topics Taught by Grades and Subjects.

Implicit in the discussion that will follow is the hope that these comments will help to improve economic literacy and education not only in Alabama school systems but throughout the United States.

1. *Teacher Background in Economics.* While many Alabama teachers have taken some formal course work in economics, there is a great need to improve their economic preparation in certain grades and subjects.

In the sampling of Workshops and Institutes that have been conducted at Samford University over the past 4 years, it was found that approximately 40% have never taken a course in economics, 35% have taken between 3 and 6 semester hours and 25% have taken 6 or more semester hours of economics.

Without question, all teachers can benefit from some formal instruction in economics simply because there is economic content in nearly every course that is offered at the college level. In 1961, the National Task Force on Economic Education recommended a minimum of 6 semester hours of economics for all high school social studies and business teachers, and 18 hours for economic teachers. Many of those interested in the field recommend a minimum of 3 hours for elementary teachers.

The teacher in elementary and secondary grades who is primarily responsible for teaching the economics course is the teacher of prime concern to those interested in economic education. In Alabama, economics teachers generally have very extensive preparation in history and other related social science studies, but for the most part have deficiencies in economics courses to teach the sections that require economic understanding. However, teachers who are responsible for economics at the secondary level meet the Task Force Criterion of 18 hours in 35% of the cases; and what is more important, many of these teachers have taken courses recently. There is much debate whether the economics teacher should be a social studies or a business teacher, but it has been found that some have extensive economic backgrounds in both fields.

We at Samford University have attempted to design a course specifically for social studies majors who may be called upon to teach the economics course at the secondary level, and for those teachers who will

Economics in the Social Sciences Curriculum

be teaching social studies in the elementary grades. However, we are not at all pleased with the percentage of perspective teachers that take economics courses at the college level.

2. *In-Service Experiences of Teachers.* Despite the known value of in-service education, about 50% of our Alabama teachers in the SMSA of Birmingham have taken advantage of the in-service economics training offered to them in Samford's Center for Business and Economic Education. This includes both elementary and secondary teachers. Currently our mailings to teachers in the Birmingham area number 300, and we find that certain school systems have not taken advantage of any of our in-service economic training programs.

In-service education has always been a practical tool for upgrading teacher education. It provides opportunities to guide teachers to perception and appreciation of the economic content of the courses that they teach.

3. *Resources Used in the Classroom.* In spite of the availability of contemporary teaching materials, many teachers still rely heavily on the traditional text-book, lecture and discussion. However, with proliferation of economic material, some innovative teachers are shying away from the traditional lecture approach. There are many excellent film strips, film transparencies, film loops, simulations and games, posters and charts, newspapers, maps, field trips, wall charts, program material, television, and outside speakers that can be drawn on to stimulate the student to new vistas of learning.

Elementary school teachers use printed materials more than would be expected, but this can be improved upon greatly. In our Birmingham City Schools we have a developmental Economic Education Program which is making use of all the materials that are available through the Joint Council of New York. We currently are running a Workshop involving 100 elementary teachers--the fifth through the eighth grades--on the use of these materials and techniques in developing concepts and principles in economic education.

4. *Teaching Methods.* Although Alabama teachers perceive the inadequacies surrounding economic education, there is not evidence that they are employing many of the new approaches to help the existing situation. In canvassing the Workshops and Institutes that we have conducted through Samford's Business and Economic Education Center, it was found that more than 50% of the teachers use only a text-book or related item; less than 20% ever use such contemporary methods as classroom role playing, community survey, student research, or closed circuit television.

Despite some of their feelings that present text-books are inadequate and that it is difficult to put the concept or principles across, they still use the more traditional approach. In our mind the traditional approach does not make economics a palatable subject to the average student. This should be the impetus to have each teacher explore concepts and get them across to the student body.

5. *Testing Economic Understanding.* Teachers are not employing pre-testing or post-testing techniques in economic understanding, which might indicate that the economic context is unimportant to some teachers. It was found that more than 35% of all teachers in the Workshops and Institutes that have been conducted do not test their students for economic concepts in the courses they teach. This is primarily concentrated in the lower and middle-school student body and, as we all know, every student in secondary education (when he reaches the 12th Grade) must take at least a 15-week course in economics. The secondary students are tested on the material that is covered by the teachers. However, it was found that many of the concepts and principles have not been taught because the teacher did not have the adequate background to develop these concepts and principles for learning by the students.

A useful research tool in economic education is the Standardized Test of Economic Understanding designed for the secondary school. Also, many personal economics tests that have been developed and validated could be used by elementary school teachers to determine whether economic concepts have been taught to their students.

6. *Teachers' Feelings Regarding Need for Improvement of Economic Education.* There is an awareness among teachers for the need of economic education, and they express definite preferences regarding methods for improving the existing conditions. More than 65% of all teachers feel there is a need to broaden their own backgrounds in economics, and they see in-service education and teacher-oriented college education courses as the best way. Of course, this survey was concentrated upon teachers who have a genuine interest and have attended Workshops and Institutes in the past. Of those surveyed nearly 50% wanted more explicit treatment of economic content in their text-books. Approximately 60% wanted correlated audio-visual resources and 50% wanted guidance in teacher manuals.

At Samford University we have given (over the past four years) graduate courses in economics to teachers who would like to participate in programs. It is possible for teachers to earn a degree--the Master of Science degree--in Education with a concentration in Economics. This requires 15 hours in economics and 15 hours in education. We offer our graduate courses in economics tuition-free and with a stipend of \$100 for approximately 3½ weeks of a concentrated course during the summer months. Materials are also given to the participants which they can take back and use in their classroom situations.

7. *Extent of Economic Topics Taught by Grades and Subjects.* Grade by-grade or subject-by-subject many teachers do not treat economic topics despite the implicit economic content in their courses. Fortunately, we have done some ground breaking in our Birmingham City Schools area on this problem; and now with the Developmental Economic Education Program (DEEP) being entered into by this school system, many good materials have been provided and disseminated to all teachers within the elementary grades as well as those in secondary education.

Efforts are now being made to determine which topics and concepts basic to understanding the economy are being emphasized at various grade

Economics in the Social Sciences Curriculum

levels and which are being ignored. We are following the recommendations of the Task Force on Economic Education, and the materials that have been distributed would emphasize the teaching of these concepts and principles, which would permit the student to become a well informed individual on economic matters.

It was felt that one of the most neglected groups of topics was that of Consumer Economics. To overcome this problem we have conducted Workshops and distributed materials that provide a background necessary for the teacher to inform the student of some of these important problems.

To improve the teaching of economics in the social science discipline, it is critical that we know exactly where to direct the effort. Much time will be devoted to programs--workshops and institutes--that will make use of all the known methods and techniques to allow teachers and students to become more economically literate.

INDUSTRY STRUCTURES AND LOGISTICS STRATEGIES

Grant M. Davis*

Department of Marketing and Transportation
Auburn University, Auburn, Alabama

INTRODUCTION

A strategy is essentially a plan designed for achieving specific or implied objectives. Within the environmental framework of the firm various strategies are perceptible: sales strategies, inventory strategies, production strategies, *ad infinitum*. The totality of these plans of action is directed toward attaining the firm's objectives. In many instances, however, management has failed to develop viable strategies concerning the logistics function.

This is not to say that logistics plans have not been developed and implemented by practitioners in the field. On the contrary, existing strategies are myopic inasmuch as exemplary emphasis is levied upon logistics work functions such as transport cost, inventory control, and other control related techniques without any overt attempt to relate the management of this activity to industry structures. The purpose of this paper is threefold: (1) to demonstrate the magnitude of logistics outlays, (2) to illustrate the tenuous "trade-off" approach to logistics strategies, and (3) to incorporate industry structure analysis into existing logistics planning. Industry structure analysis should increase the efficiency of any micro-logistics system.

MAGNITUDE OF LOGISTICS COSTS

Logistics management fundamentally entails managing and coordinating physical supply and physical distribution.¹ In this regard, the concept of logistics is more comprehensive than the popular physical distribution concept heralded in contemporary marketing literature.² Nevertheless, factor outlays associated with the logistics function are increasing annually and constitutes a significant category of costs. Also, domestic transportation demand and related output are expanding rapidly. Not only were 1.834 trillion intercity freight ton-miles produced during 1968,³

*Present Address: Oren Harris Professor of Transportation, College of Business Administration, University of Arkansas, Fayetteville.

¹For an interesting definition of military logistics, consult: Fred Gluck, *A Compendium of Authenticated Logistics Terms and Definitions* (Wright-Patterson Air Force Base, Ohio; School of Systems and Logistics, Technical Report No. 5, 1970), p. 249.

²See Walter B. Wentz and Arnold I. Eyrich, *Marketing: Theory and Application* (New York: Harcourt, Brace & World, Inc. 1970), Chapters 17 and 18, for excellent treatment of physical distribution permeated with a marketing philosophy.

³U. S. Interstate Commerce Commission, *83rd Annual Report: 1969* (Washington: U. S. Government Printing Office, 1969), p. 87.

Industry Structures and Logistics Strategies

but transportation output is forecast to exceed 2.5 trillion ton-miles by the end of fiscal year 1975. Furthermore, it is anticipated that outlays for logistics will exceed \$258 billion within the next four years.⁴

Pragmatism dictates that logistics expenditures be examined on both macro and micro levels. Aggregate logistics outlays are depicted in Table 1. These data were computed from percentage distributions developed by Professor J. L. Heskett during the course of his 1963 landmark study regarding logistics outlays. As noted, aggregate expenditures in monetary terms have almost redoubled during the past decade. As Table I illustrates, transportation factor outlays have soared from \$50.4 billion during fiscal year 1960 to \$94.3 billion in fiscal year 1969. When transportation expenditures are juxtaposed with promotion outlays, the monetary magnitude of transport cost is diminished. Although transportation cost has remained relatively constant when expressed as a percentage of gross national product, Professors Heskett, Ivie, and Glaskowsky's definition of business logistics would indicate that macrologistics outlays comprise 55 percent of GNP--a polemical estimate.⁵

Regarding micro-costs of logistics, Table 2 portrays estimated distribution outlays developed by Professor Edward W. Smykay for the year 1963. Although examining cost for a given moment in time appears at best a pedagogical exercise, Professor Smykay's view of distribution cost is important. As indicated in Table 2, costs are disaggregated on the basis of transportation, packaging, inventory, handling, and communications-order processing. By excluding physical supply outlays Smykay's estimates considerably understates aggregate logistics expenditures. On the other hand, Professor Charles A. Taff indicates that transportation, inventory carrying charges, and packaging and handling constitute, respectively, 10, 5, and 4 percent of GNP.⁶ My own research suggests that approximately 20 to 25 percent of gross national product is directly attributable to the logistics function when promotion is excluded. Significantly, conservative estimates indicate that gross logistics outlays could be reduced by one percent if proper management techniques were employed.⁷ Retrospectively, not only is the absolute magnitude of logistics costs economically significant, but additional management attention should be directed to the function.

⁴Grant M. Davis, *The Department of Transportation* (Lexington, Mass: D.C. Heath and Co., 1970), Chapter 7. This forecast was derived by applying Professor Heskett's estimates of logistics costs to anticipated gross national product figures.

⁵A review of the current logistics literature indicates a wide disparity in estimates of the total cost of logistics.

⁶Charles A. Taff, *Management of Traffic and Physical Distribution*, 4th ed. (Homewood, Illinois: Richard D. Irwin, Inc., 1968) pp. 708.

⁷Robert P. Neuschel, "Physical Distribution Forgotten Frontier," *Harvard Business Review*, Vol. XLV, No. 2 (March, April, 1967), pp. 125-134.

TABLE 1. Estimated logistics expenditures (billions of dollars).

Activity	Cost					
	1960	1965	1966	1967	1968	1969
Production (45%) ¹	\$226.6	\$308.2	\$337.5	\$357.1	\$401.6	\$424.3
Promotion (40%) ²	201.5	274.0	300.0	317.4	357.0	377.1
Transportation (10%) ³	50.4	68.5	75.0	79.4	89.3	94.3
Others (5%) ⁴	25.2	34.2	37.4	39.6	44.6	47.1
	\$503.7	\$684.9	\$749.9	\$793.5	\$892.5	\$942.8

Cost ascertained by applying percentage distribution determined by Professor J. L. Heskett, *Macro-Economic Cost of Physical Distribution* paper presented at the Transportation Research Forum, Pittsburgh, Pennsylvania, 1962. Transportation Percentage gleaned from Transportation Association of America.

¹Includes farm production and value added to raw materials by manufacturing, and all value added to natural resources by mining, petroleum, and fishing development.

²Includes all sales promotion.

³Transportation outlays only.

⁴Includes storage and inventory holding cost.

THE CONCEPT OF LOGISTICS "TRADE-OFFS"

The existing logistics and physical distribution literature perceives the concept of trade-offs as sacrosanct. An almost infinite number of monetary "trade-offs" are incorporated within the widely publicized "total cost" approach to logistics management. This conceptual approach primarily connotes managerial decision making predicated upon the aggregate charges associated with transporting a unit of product from the point of procurement to the ultimate consumer.⁸ Functioning

⁸A single inclusive definition of logistics is polemical. For varying definitions and approaches to the concept, consult Donald J. Bowersox, Edward W. Smykay and Bernard J. LaLonde, *Physical Distribution Management*, revised ed., (New York: The MacMillan Co., 1968), pp. 5-6; J. L. Heskett, Robert M. Ivie, and Nicholas A. Glaskowsky, Jr., *Business Logistics* (New York: The Ronald Press, 1964), Chapter 2; Charles A. Taff, *Management of Traffic and Physical Distribution*, 4th ed. (Homewood, Ill: Richard D. Irwin, Inc., 1968), Chapter 1; and Jones A. Constantin, *Principles of Logistics Management* (New York: Appleton-Century-Crofts, 1966), Chapter 1.

Industry Structures and Logistics Strategies

TABLE 2. Estimated cost of physical distribution, 1963.

Cost Item	Total Cost (billions of dollars)	Estimated Physical Distribution	
		(percent)	(billions of dollars)
1. Transportation (freight only)	45	100	45.0
2. Packaging	20	50	10.0
3. Inventory	25	50	12.5
4. Handling	NA	--	--
5. Communications and order processing	NA	--	--
Totals			67.5

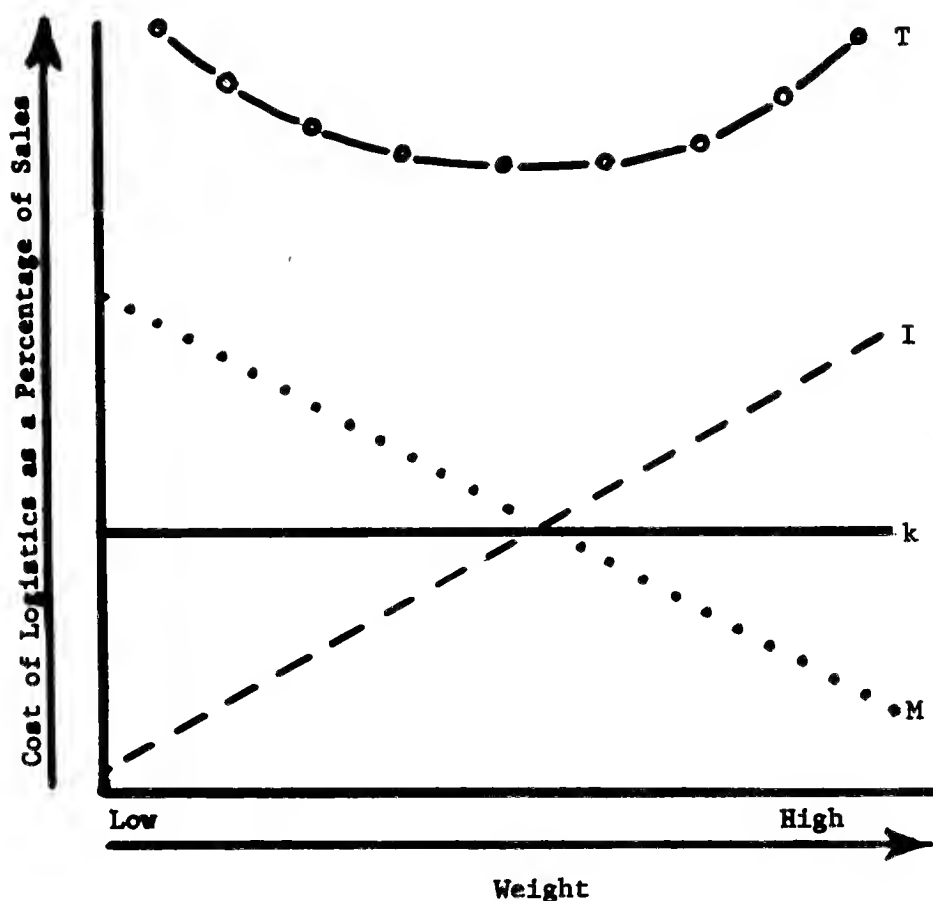
From Edward W. Smykay, "Physical Distribution, Military Logistics, and Marketing Management," *Houston Business Review*, Winter 1964-1965, p. 1.

with discrete financial and physical parameters, no single factor or process is dominant in the "total cost" approach to logistics management.

Characteristic trade-offs permeating any micro-logistics system are analogous to a simple economic order size inventory model. These are illustrated in Figure 1. As noted, inventory holding costs are reciprocal to movement outlays (transportation). Total costs, moreover, are curvilinear because of the functional interrelationships between movement and inventory holding expenditures. Lost sales (opportunity costs) are treated as a constant in this example. Logistics trade-off decisions primarily involve: (1) inventory holding costs vs. customer service levels; (2) transportation costs vs. customer service levels; (3) transportation and inventory holding expenses vs. production; etc.⁹ All logistics trade-off decisions, moreover, have certain homogeneous interrelationships and interfaces.¹⁰

⁹ Parenthetically most physical distribution and logistics authorities tend to categorize logistics components into four comprehensive classes: (1) inventory, (2) transportation, (3) customer service, and (4) production scheduling. In this regard, consult John T. McCullough, "Putting PD in Perspective," *Distribution Management*, Vol. LXVIII, No. 2, (February, 1969), p. 29, where Robert Sherman states: "The guts of the physical distribution concept and the payoff potential is in the trade-offs: Inventory vs. transportation and production vs. inventory."

¹⁰ Heskett, Ivie, and Glaskowsky, *op. cit.*, p. 29.



- Lost Sales Cost (k) is a constant that remains fixed during a given period
- - - Inventory Holding Cost (I) is a cost that varies directly; Ax
- Movement Cost (M) is a cost that varies inversely; B/x
- Total Cost (T); or $T = Ax + B/x + k$

FIGURE 1.

As depicted in Figure 1, a pedagogic paradigm appropriate for evaluating the finite value of logistical trade-off decisions would necessarily incorporate usage of a simple algebraic equation of the type, $T = Ax + B/x + k$, which in effect is the sum of a straight line ($Ax + k$) and a rectangular hyperbola (B/x). Movement costs, B/x , varies inversely with inventory holding costs Ax ; whereas k , lost sales, is treated as a constant. This simple equation provides a viable model with which firms pragmatically estimate the financial impact of a given decision that involves trade-off alternatives. The equation's basic value, however, resides with its ability to demonstrate functional interrelationships between the variables, dependent variables,

Industry Structures and Logistics Strategies

and constants which are present in any micro-logistics system. Paradoxically, the model assumes conditions of certainty but can be readily modified to analyze problems under conditions of risk and uncertainty.¹¹ Nevertheless, trade-offs are merely one aspect of logistics.

LOGISTICS WORK FUNCTIONS AND BASIC STRATEGIES

Developing meaningful logistics strategies requires a detailed integration of logistics work functions with price and promotion strategies. Figure 2, illustrates a managerial overview of a hypothetical firm as it relates to an amorphous market. As noted, the three predominant strategies are integrated and tailored to specific market segments. Procurement, moreover, reacts to market changes. Relative to the distribution aspects of Figure 2, Professor William J. Stanton asserts that major distribution work functions are:

1. Determining inventory locations and establishing a warehousing system.
2. Establishing a materials handling system.
3. Developing and maintaining an inventory control system.
4. Establishing order processing procedures.
5. Selecting specific forms of transportation.¹²

Stanton's approach reflects a marketing orientation inasmuch as procurement is neglected.

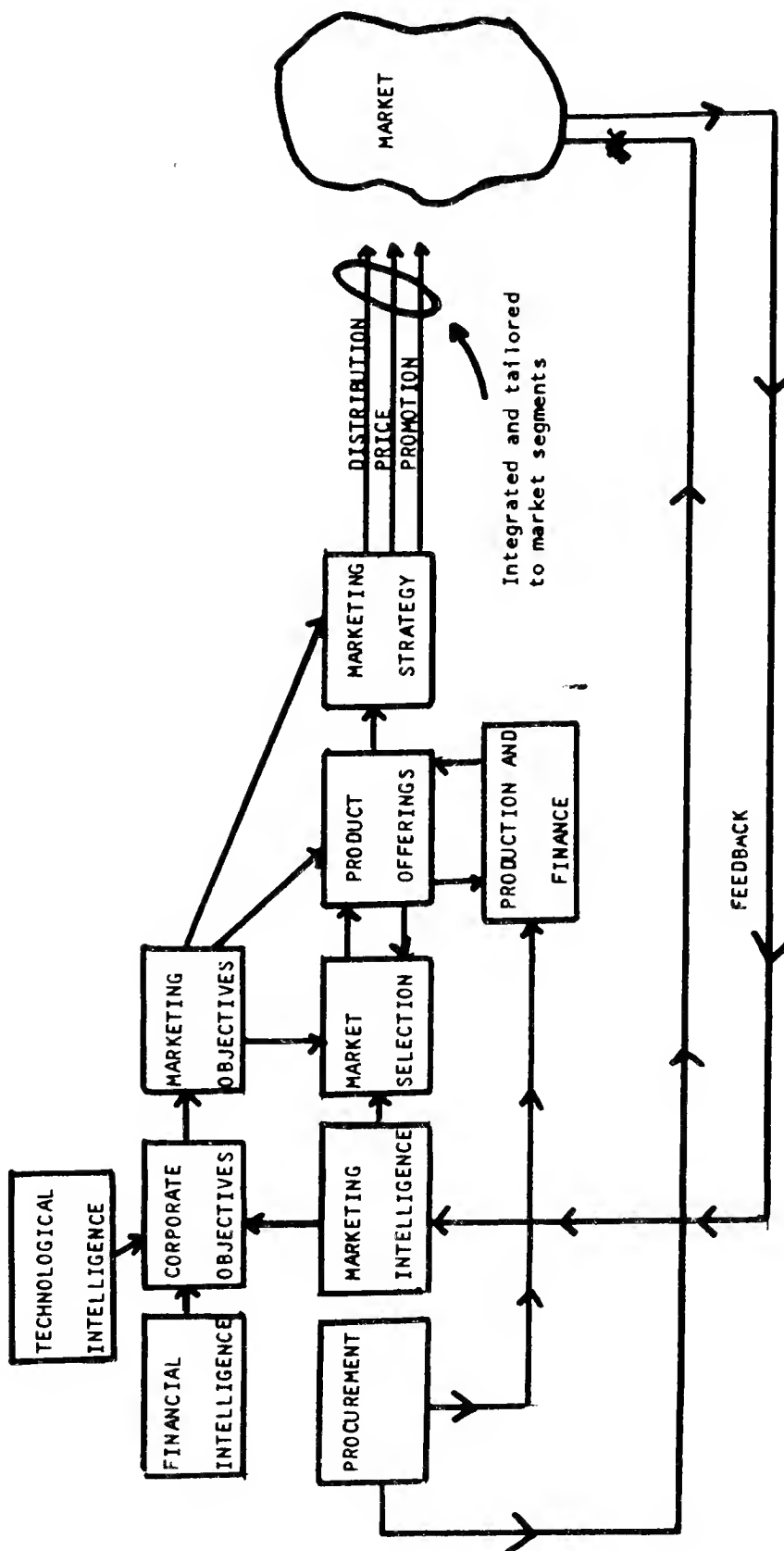
A more comprehensive conceptualization of logistics work functions is presented in Figure 3. In this approach physical supply is coordinated with physical distribution. Moreover, transportation and communications, the commonalties of all micro-logistics systems, function as a nexus between the system's several components. Regarding this approach, Graham W. Rider contends that the six basic work functions of logistics embrace: (1) traffic management, (2) warehousing, (3) inventory control, (4) procurement, (5) order processing, and (6) information data gathering.¹³ Procurement constitutes the major difference between Stanton's and Rider's conceptions of logistics work functions.

The foremost challenge confronting logistics management is the development of viable and effective strategies relative to both physical supply

¹¹For a specialized investigation of logistics decision-making under conditions of uncertainty, see Grant M. Davis, "Decision-Making Under Conditions of Uncertainty--An application to Intermodal Carrier Selection," *The Logistics Review*, Vol. 6, No. 30 (Winter, 1971), p. 3.

¹²William J. Stanton, *Fundamentals of Marketing*, 3rd. ed. (New York: McGraw-Hill Book Co., 1971), p. 377.

¹³Graham W. Rider, *An Exploration of the Concept of Logistics: A Constitutive Approach* (unpublished D.B.A. dissertation, Arizona State University, 1970), pp. 44-128.



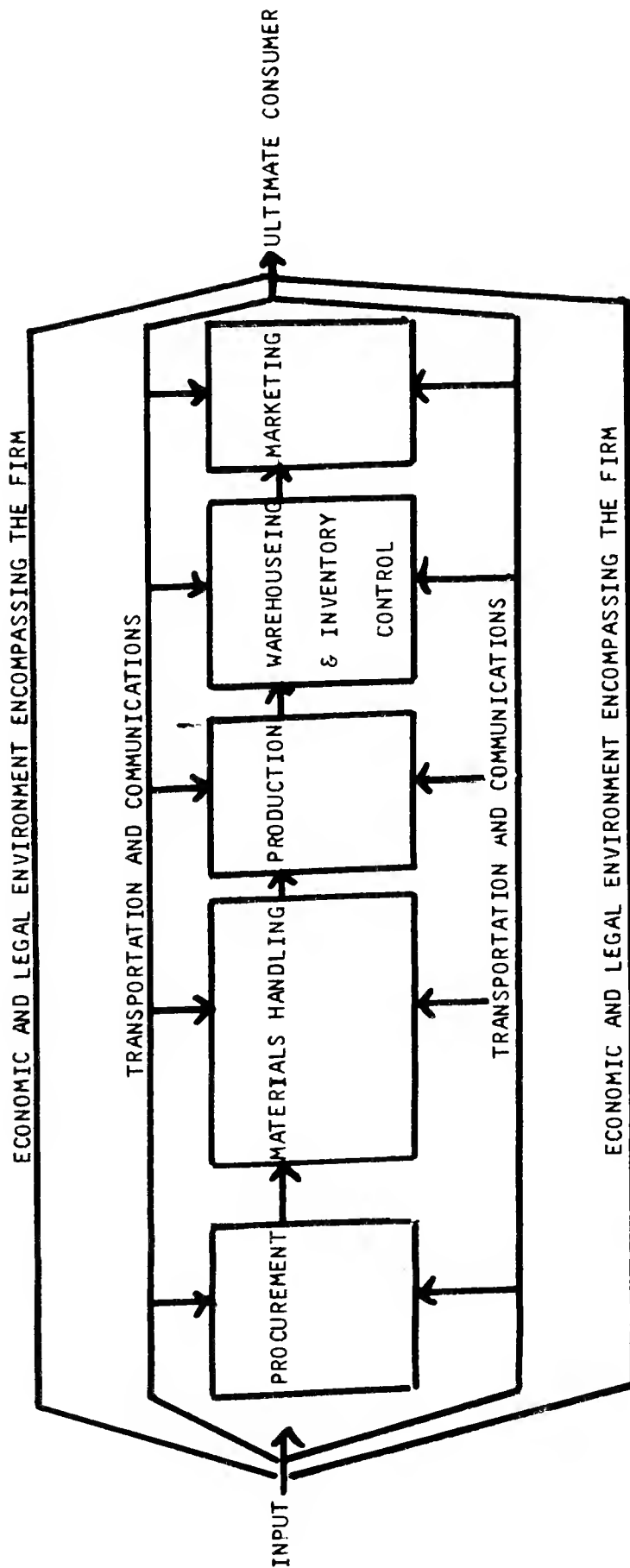


FIGURE 3. Micro logistics system: By function.

and physical distribution. Several basic, conceivable strategies are:

1. Volume control-- the control of physical materials flows through transfer of title.¹⁴
2. Customer Service Levels--preventing stockouts through inventory control.
3. Time and Place Utility Adjustments--utilization of warehousing and transportation modes to adjust to changes in market demand or supply.
4. Price Stability--endeavors to prevent price fluctuations through warehousing, inventory control, and procurement.
5. Channel of Distribution Alternatives--Channel selection based upon overall firm objectives.

These five basic strategies are applicable to both physical supply and demand. Nevertheless, one prodigious factor is ignored--industry structures.

INDUSTRY STRUCTURES AND LOGISTICS

Unequivocally, industry structures represent an absolute parameter within which logistics strategies may be developed. That is to say, a strategy designed to manipulate either demand or supply would be improbable in pure competition but not in monopolistic competition. In this section strategies tailored to industry structures will be developed briefly. Specific strategies, of course, would vary from firm to firm. Table 3 depicts the four basic industry structures which will be analyzed. Pure competition will be examined separately, whereas monopolistic competition will be analyzed as a unit. Oligopoly, on the other hand, will also be studied separately.

Pure Competition

A micro-logistics system functioning within a purely competitive industry structure lacks the ability to manipulate demand and exercises no control over price. Cost reductions constitutes the motif of any logistics strategy and should adumbrate all logistics decisions. Indeed, financial profits are attainable only through improved efficiency. Cooperative ventures¹⁵ perforce represent the quintessence of any strategy in pure competition.¹⁶

¹⁴For an indepth analysis of volume control as it relates to logistics see Grant M. Davis, "F.O.B. Terms--A Framework for Purchasing Decision Making," *Journal of Purchasing*, Vol. 10, No. 1 (February, 1969).

¹⁵Most marketing cooperatives are in effect service wholesalers.

¹⁶Antitrust statutes and other restraint of trade laws seriously reduce the level of cooperation that a firm can obtain.

TABLE 3. Market structures and major characteristics.

Type of Market	Number of Producers	Nature of the Marketing Effort	Control over Price
Pure Competition	Many sellers of homogeneous, standardized products.	None	None
Pure Monopoly	One seller of a product with no substitution in either direction.	Promotion strategy designed to increase goodwill for the firm.	Limited by consumer choice of government controls.
Monopolistic Competition	Numerous sellers of similar but differentiated products.	Extensive use of promotion with emphasis upon trade marks, style variations, quality differences, and brand names. The marketing efforts endeavor to create product differences—real imagery.	Restricted because of a possibility that consumers will change to competing goods.
Oligopoly	Few sellers of standardized or differentiated products.	Extensive use of promotion in differentiated product and goodwill promotion in others.	Limited by fear of what other producers may do.

Compiled from R. Murray Havens, John S. Henderson, and Dale L. Cramer, *Economics: Principles of Income, Prices, and Growth* (New York: The Macmillan Co., 1966).

Substantial savings may be gleaned through cooperative procurement and distribution activities. Transportation factor outlays alone can be materially reduced by joining shippers cooperatives. Professors Smykay and Shiele enumerate several benefits from belonging to a shippers cooperative:

1. Reduction in transportation charges. . .
2. Savings in time since the association ships by direct carload shipments which arrive in a shorter time.
3. Reduction in loss and damage due to the loading and unloading of full cars by specialists in the particular types of commodities.
4. Savings in paperwork costs since the association handles all the bookkeeping arrangements and submits single bills to members periodically.
5. Elimination of time consuming details since the association takes care of all claims against carriers, expedites shipments and performs other traffic services.
6. Savings in lower insurance premium rates since the association provides broader coverage than is possible by an individual shipper.¹⁷

Other strategies are also in order. First, volume control is essential if cooperatives are used. Second, channels of distribution should be relatively simple and direct. That is to say, the number of middlemen should be minimized. Retrospectively, all strategies in pure competition should theoretically be directed toward cost minimization.

Monopoly and Monopolistic Competition

Monopolistic competition and monopoly are combined for strategy development purposes inasmuch as the elasticity of the average revenue curve determines the extent and degree of possible logistical strategies in these two industry structures. Relative to weak monopolies, or a firm that has failed to strongly differentiate its product, several conceivable strategies are in order. First, cooperative arrangement should be utilized wherever possible. This action is necessary if costs are to be minimized. Secondly, because of obvious product substitution, high levels of customer service must be stressed. In this regard, inventory control is not only mandatory but careful warehouse site location is important. Thirdly, packaging is significant because of product substitutability. Fourth, channels of distribution must remain relatively simple and volume control exercised since customer service is essential.¹⁸ In fact, the firm should consider private carriage if customer service receives a high priority by management.

¹⁷Edward W. Smykay and Irene Shiele, "Minimizing Transportation Costs with Shippers Co-operatives," from *Marketing Logistics* Norton E. Marks and Robert M. Taylor, ed. (New York: John Wiley & Sons, Inc., 1967), p. 227.

¹⁸Davis, *Loc. cit.*

Industry Structures and Logistics Strategies

A strong monopolist, and the firm in monopolistic competition that has strongly differentiated its product, should develop logistics plans which emphasize procurement and distribution cost control. For instance, volume control would enable the firm to purchase and sell in carload quantities. Second, regional warehouses may not be required because of low customer service requirements. Furthermore, elaborate and sophisticated channels of distribution may be developed to reduce overall costs. In summary, firms enjoying relatively inelastic average revenues curves can focus their managerial efforts upon supply aspects of the firm. Nevertheless, logistics managers cannot totally ignore the proposition that the policies of a monopolist may be constrained by indirect competition of all goods for the consumer's expenditures and by the existence of reasonably adequate substitute goods.¹⁹

Oligopoly

The last industry structure to be considered is oligopoly. Logistics strategies and actions in this particular structure are dependent upon whether the oligopoly's product is standardized or differentiated. With respect to a standardized oligopoly, the same logistical strategies advocated for a weak monopoly are applicable. In other words, due to product substitution customer service requirements would be high, thereby necessitating greater inventory levels, premium transportation outlays, and greater emphasis upon warehousing. These same strategies would also be applicable in the case of a differentiated oligopoly wherein a high degree of product uniqueness had not been achieved. On the other hand, strategies developed where product differentiation is weak are in order for oligopolistic firms where product substitution exists.²⁰

CONCLUSIONS

Not only are logistics costs economically significant but they are also increasing each year. It has been demonstrated in this paper that aggregate logistics outlays constitutes approximately 20 percent of gross national product. Moreover, most managerial endeavors associated with the logistics function are focused upon the tenuous concept of "trade-offs."

This paper has emphasized the necessity for integrating the work functions of logistics with strategies such as customer service, volume control, channels of distribution, time and place utility, and procurement to assist in achieving objectives of the firm. Furthermore, it was shown that logistics strategies failed to incorporate industry structures in overall considerations of physical supply and physical distribution--a myopic view when examining the environmental parameters surrounding the individual firm and the interrelationships of the logistics function with all facets of enterprise.

¹⁹C. E. Ferguson and S. Charles Maurice, *Economic Analysis* (Homewood, Ill: Richard D. Irwin, Inc., 1970), p. 189.

²⁰Price is ignored inasmuch as it is a separate strategy.

Pure competition, monopoly, monopolistic competition, and oligopoly are unique industry structures which directly affect the cogency of any micro-logistics system by establishing the absolute boundaries within which the system functions. The logistics practitioner would be well advised to consider these economic parameters when developing realistic logistical plans and activities.

George Wishart: His Role in the Scottish Reformation Movement

GEORGE WISHART: HIS ROLE IN THE SCOTTISH REFORMATION MOVEMENT

Richard Glen Eaves
History Department
Auburn University, Auburn, Alabama

Scotland's Reformation succeeded in 1560 when Queen Elizabeth gave soldiers, funds, and ships to aid the rebellion by the Protestant Lords of the Congregation. Prior to this time, however, several reformers had contributed to the momentum necessary to carry the Reformation movement forward. Among these reformers was the Rev. George Wishart, whose sermons spread Protestantism. Just as the burning of Patrick Hamilton in 1528 gave impetus to the Scottish Reformation struggle, so did the martyrdom of George Wishart in 1546.

Little is known of Wishart's early life. He was born about 1513, the son of James Wishart of Pitarrow, who served as Clerk of Justiciary and King's Advocate during the reign of James IV. His father died, leaving the responsibilities of child-rearing to his mother, Elizabeth Learmont Wishart. Wishart entered the clerical profession in which several members of his family had attained prominence. He was a student at Cambridge University and later taught in Corpus Christi College, Cambridge. He spent some time in Germany and may have attended a university there. His knowledge of Greek is evident by his later teaching the Greek New Testament at Montrose. In the course of his studies, he became a supporter of the Reformation thought.¹

In 1534 John Erskine of Dun founded at Montrose a school for teaching the Greek language. Wishart, having recently returned from the continent, succeeded a Frenchman as supervisor of the school and imported copies of the Greek New Testament for distribution to his students.² Evidence that Wishart taught here is given by Alexander Petrie in his *Compendious Church History* of 1662. Petrie wrote that as a young man he heard from elderly men that Wishart had once served as schoolmaster and teacher of the Greek New Testament at Montrose. Also, James Melville's diary contained references to his father, Richard Melville, as being a companion of Wishart at Montrose.³

Wishart's teaching of the New Testament in Greek was reported to John Hepburn, bishop of Brechin, who summoned the reformer to appear in his diocesan court in 1538. Fearing persecution, Wishart wisely fled instead to Cambridge where he entered Corpus Christi College. Cambridge was already a seat of religious reform sentiment. For example, it was here that Hugh Latimer had already preached reform and Thomas Cranmer and Nicholas Ridley had both read the scriptures in English. At Cambridge Wishart became personally acquainted with Hugh Latimer. During a preaching tour in 1531, Latimer had denounced in Bristol the doctrine of purgatory and the intercession of saints. After Latimer became bishop of Worcester in 1535, he continued to favor reformed doctrines and tried to protect George Wishart. Wishart obtained from Latimer the designation of "reader," which gave him authority to preach. He proceeded to Bristol, where he preached in the Church of St. Nicholas on Sunday, May 15, 1539.

In denying any power of saints to intercede for man, Wishart held that Christ "onely is our mediator and intercessour." He also taught that the Virgin Mary had no merit for her son or for others.⁴ Wishart was accused of heresy by John Kerne, dean of Worcester, and was subsequently arrested by the mayor of Bristol and brought before the primate, Archbishop Thomas Cranmer, and several other prelates, including the bishops of Bath, Norwich, and Chichester. He was convicted and condemned to die, but was allowed to escape burning by publicly burning his faggot, which was the usual symbol of recantation.⁵

Having escaped execution for preaching in Bristol, Wishart left either in late 1539 or early 1540 for the continent, where he spent some time in Germany, sailed on the Rhine, and may have visited Switzerland. Unfortunately, there is no known record of his activities on the continent. After his return to England, probably in early 1543, he translated from Latin the "Confession of the Church and Congregation of Switzerland," or the "Helvetic Confession," which was printed after his death, most likely in 1548.⁶ This translation has prompted speculation that Wishart was associated with some of the Swiss reformers during his continental sojourn.

After his return to England from the continent, Wishart obtained employment as a tutor at Cambridge in Corpus Christi College.⁷ One of his pupils, Emery Tylney, has left a colorful and laudatory account of Wishart's appearance and character:

He was a man, says Tilney, of tall stature, bald-headed, and on the same a round French cap of the best; judged of melancholic complexion by his physiognomy; black-haired, long-bearded, comely of personage, well spoken after his country of Scotland; courteous, lowly, lovely, glad to teach, desirous to learn, and was well traveled; having upon him for his habit or clothing never but a mantle freese gown to the shoes, a black Milan fustian doublet, and plain black hosen, coarse new canvas for his shirts, and white falling bands, and cuffs at the hands. If I should declare his love to me and all men; his charity to the poor in giving, relieving, caring, helping, providing, yea, infinitely studying how to do good unto all and to hurt none, I should sooner want words than just cause to commend him.⁸

Scottish commissioners came to London in June 1543 for the purpose of negotiating the marriage of Edward Prince of Wales and Mary Queen of Scots. While both were mere children at this time, such a marriage alliance was vigorously sought by Henry VIII as a means to eventual union of England and Scotland. The Scottish delegation included William Cunningham, the fourth Earl of Glencairn; Sir George Douglas; James Learmont of Balcomie, a relative of Wishart on his mother's side; William Hamilton of Sanquhar; and Henry Balnaves. After negotiating the marriage treaty with English commissioners at Greenwich on July 1st, the Scots prepared to leave for home. Before going, however, James Learmont persuaded his relative, George Wishart, to leave Cambridge and return with the Scottish delegation to work for religious reform in Scotland. Learmont believed the time was ripe for a reformation movement to make significant gains.⁹ One diarist wrote that "In this

time there was one great heresy in Dundee: there they destroyed the kirks, and would have destroyed Aberbrothoc Kirk were it not for the Lord Ogilvie."¹ Apparently, some of the more zealous of the reformers attacked images in the churches and condemned the whole idea of having monasteries. The Parliament of Scotland responded to the growing religious reform movement by urging both ecclesiastical and civil authorities to be more vigilant in suppressing heresy.¹¹

Returning to Scotland in late July, 1543, Wishart found that David Cardinal Beaton, archbishop of St. Andrews, primate, papal legate, and chancellor of Scotland, had great influence with the regent (or governor), James Hamilton, second Earl of Arran. Arran, having briefly joined the Reformed faith, had recently been persuaded by Beaton to return to the Catholic fold. The atmosphere for the reformers had clearly suffered a setback. Wishart, nevertheless, made his headquarters at his native home of Pitarrow, which was located in a rural area about fifteen miles from Montrose and on the east coast of the shire of Angus. He remained in this general area most of the time from July 1543 until the spring of 1545.

After returning to Pitarrow, the reformer resumed his public scripture reading and comments in the native tongue, which the Scottish estates had declared legal by an act on March 19, 1543. The estates even established the death penalty for anyone who should preach against reading the scriptures in the vernacular. Over much of Europe the death penalty was meted out for preaching in the vernacular; that such a change had been instituted by the Scottish estates in 1543 is indicative of receptivity for at least mild reform in Scotland.¹² Wishart soon began preaching in Montrose, and afterward in Dundee, where he was well received and had numerous followers. He taught the Book of Romans in Dundee until ordered to desist by Robert Mill, a magistrate of Dundee. Mill publicly presented this order in the name of the Earl of Arran and Queen Mary of Guise-Lorraine. Wishart lamented the fact that a messenger of God was forbidden to preach, but said that God would send messengers who were not afraid of burning or banishment. In the church at the time were various nobles, who urged the reformer to continue preaching in Dundee or go to the north country. Wishart, however, had earlier promised William Cunningham, Earl of Glencairn, that he would preach next in Ayrshire, and he chose to go there.

Ayrshire was under jurisdiction of Archbishop Gavin Dunbar of Glasgow, who worked vigorously to suppress the reformers in his diocese. This area was known as the land of the Scottish Lollards, followers of Dr. John Wyclif, the fourteenth century Oxford professor and religious reformer. By preaching here, Wishart would build upon the earlier work of the Lollards and stimulate further growth of Protestantism. Hearing of Wishart's preaching in Ayrshire, Archbishop Dunbar--at the instigation of Cardinal Beaton, according to Knox--came with a small contingent and seized control of the church. The Earl of Glencairn and George Crawford of Loch Norris gathered their friends and came to the town of Ayr with all diligence, as did various nobles from Kyle, an old Lollard stronghold. When they had all assembled, Wishart's supporters decided to take over the church; Wishart, however, chose to give up the church and led his followers and congregation to Market Cross, where, according to Knox, he delivered a most impressive sermon. Archbishop Dunbar preached in the church at Ayr and afterwards left town.¹³

During his stay in western Scotland, Wishart preached and did evangelistic work mainly in the district of Kyle. He preached for a time in the parish church of Galston, under protection of John Lockhart of Barr, a Protestant landowner. Invited to preach in the neighboring parish at Mauchline, Wishart agreed, but his use of the church was prohibited by Sir Hugh Campbell, sheriff of Ayrshire, who placed a watch over the church doors. Another prominent landowner, one Hugh Campbell of Kinzeancleugh, joined with some of his friends of like mind, proposing to remove forcibly the guards and enter the church so Wishart could preach there. Wishart, however, once again dissuaded his supporters from using force. He asserted that "Christ Jesus is as potent in the fields as in the kirk. He himself oftener preached on the mountain, in the desert, and at the seaside, than in the temple. God sends by me the Word of Peace, and the blood of no man must be shed this day for the preaching of it." Wishart then proceeded to a meadow and preached from a stone fence for three hours to a receptive audience. This sermon brought the conversion of Lawrence Rankin, lord of Sheill, who had been known as a very wicked man, according to Knox. The conversion of this prominent man greatly impressed those present. Thanks to the protection of Gilbert Kennedy, third Earl of Cassilis, and the Earl of Glencairn, Wishart preached about four weeks in Ayrshire before being recalled to Dundee.¹⁴

While Wishart was preaching in Kyle, word came that the plague had erupted in Dundee in August, 1545, as well as in many other areas of Scotland. It was so severe that many died each day. Wishart, to the regret of many in Kyle, returned to Dundee to preach and help care for the sick. "Cumming Vnto Dondie, the joy of the faithful was exceeding great."¹⁵ He announced that he would preach the following day. Because most people were either sick with the plague or with those who were stricken, he chose to preach at the East Gate of the city walls surrounding Dundee. Those who were healthy gathered within the walls and the sick on the outside. His sermon was favorably received, and he preached often here at Dundee and helped care for the sick.¹⁶

Knox wrote: "While he was spending his life to comfort the afflicted, the devil ceased not to stirre up his owne sonne the Cardinall againe who corrupted by money a desperate prieste . . . [named John Wighton] to slay the said M. George"¹⁷ John Wighton, a priest of Dundee reputed to be hired by Beaton to assassinate Wishart, entered the house of worship and hid with his dagger near the pulpit. As Wishart descended from the pulpit, however, he quickly became suspicious of the priest, grabbed him, and seized the priest's dagger.¹⁸ The priest then fell down at Wishart's feet and begged for mercy, while some of Wishart's followers demanded the execution of the would-be-assailant. Wishart persuaded his supporters to spare the priest and they let him go free.¹⁹ This episode was another warning of the physical risk inherent in Wishart's religious nonconformity.

Wishart stayed in Dundee until the plague had ended. Meanwhile, the Earls of Cassilis and Glencairn had written to the reformer, asking him to meet them on January 13, 1546 in Edinburgh, where a hearing would be held before a synod of bishops in order that Wishart could get a public audience for his reform proposals. Before going, Wishart went to Montrose where he preached a few times. Meanwhile, another plan was devised to have Wishart murdered. A messenger was sent to Wishart at Montrose with a letter stating

George Wishart: His Role in the Scottish Reformation Movement

that his friend, John Kinnear of Kinnear, in Fife, was gravely ill and wished to see him right away. Wishart left with a few friends, against the advice of another associate, John Erskine, but he began subsequently to suspect an attempt on his life. He asked some of his friends to ride ahead and have a look, whereupon they found that about sixty horsemen were indeed waiting to ambush the reformer. Referring to Cardinal Beaton, Wishart stated that he believed his life would eventually be taken by "that blood thriftie mans hands, but it will not be of this maner." The trap was thus avoided and he returned to Montrose.²⁰

Beginning the journey to Edinburgh in late November, 1545, Wishart stopped near Dundee at the village of Invergowrie for a brief visit in the home of one of his converts, James Watson. Wishart next travelled to Perth, taking this longer route to Edinburgh because of Cardinal Beaton's strict jurisdiction in the eastern area of Fife. He reached Edinburgh in early December, hoping to meet the Earls of Cassilis and Glencairn and other nobles from Kyle who had been scheduled to rendezvous there. Disappointed because they had not arrived (possibly because of fear of the cardinal and Arran), Wishart was persuaded to keep his arrival secret for a few days. He quickly tired of hiding, however, and, against the advice of some of his friends who feared for his personal safety, resumed preaching. He delivered a sermon at Leith on the second Sunday in December. His followers were concerned because the governor and cardinal were scheduled to arrive in Edinburgh shortly.

During this time Wishart became associated with three important Protestants: Alexander Crichton of Brunstone, Hugh Douglas of Longniddry, and John Cockburn of Ormiston. After he preached at Leith these people entertained him in their homes and provided for his safety. Since these men were close to Wishart during the final period of his ministry, it is appropriate to comment briefly about them. Crichton had earlier supported the cause of the religious reformers, but probably more because of opposition to Beaton than for any other reason. He had been a good friend of Beaton in 1539, the cardinal having sent him to Rome on a diplomatic mission. After having quarrelled with Beaton, Crichton gained the favor of the Earl of Arran, who sent him to France and England on diplomatic business. Later renouncing his support of Arran, Crichton became acquainted with Sir Ralph Sadler, Henry VIII's envoy in Scotland. Soon thereafter Crichton became interested in promoting English efforts to break Scotland away from Rome.

Hugh Douglas was known as one of the firmly committed Protestants. He hired John Knox to live in his house and tutor his sons, Francis and George. Knox had lived with the Douglasses for about eighteen months before Wishart came to Edinburgh. John Cockburn of Ormiston, who strongly supported Wishart's ministry, was hereditary constable of Haddington. He was one of John Knox's early converts and throughout his life remained Knox's close friend. Alison, Cockburn's wife, was also a staunch believer in the reformed doctrines. With protection from these three men, Wishart preached to a substantial number of people in the parish church of Inveresk in the morning and afternoon on the Sunday following his preaching at Leith.

Among those present at the afternoon service was Sir George Douglas, brother of the powerful Archibald Douglas, sixth Earl of Angus. Sir George

Douglas stated that the regent and cardinal would hear of his presence there that day, because they were then already in nearby Edinburgh. He asserted, however, that he would acknowledge his presence, would maintain the doctrines that he had heard, and would even defend Wishart to the limits of his power. Those present were greatly encouraged that a member of the powerful Douglas family had given such strong support to the Reform movement. Sir George Douglas was well liked by Henry VIII and among the Anglophiles of Scotland (as opposed to the pro-French leaders). The importance of Douglas' adherence to the Reformed faith is evidenced by the fact that his second son, James, would eventually become Earl of Morton and Protestant regent of Scotland.²¹

After the regent and cardinal arrived in Edinburgh, Wishart was taken to the mansion of Longniddry for greater safety. John Knox, armed with a two-handed sword, travelled with Wishart, as his protector. Longniddry was in the parish of Gladsmuir, and only four miles from the village of Tranent. Wishart preached at Tranent to large gatherings on two consecutive Sundays. In all these latter sermons he spoke of the brief time which he had left. He went to the town of Haddington, accompanied by Knox, on January 14, 1546, and was entertained here by David Forrest, a prominent townsman of the Reformed faith. (Eventually, Forrest had to take refuge in England in order to escape persecution.) Wishart preached to small audiences in Haddington for two days in succession. One reason given for the small turnout was that Patrick Hepburn, Earl of Bothwell, (father of the later Bothwell who murdered Henry Stuart, Lord Darnley) may have ordered the people of the town and surrounding countryside not to attend Wishart's sermons. Bothwell, a friend of Cardinal Beaton, had lands in the area, which increased fear of persecution among the citizens. On the third day just before Wishart was to deliver his sermon, a messenger came with a letter from the Earls of Cassilis and Glencairn. The letter presented another disappointment to Wishart, for the nobles from the area of Ayrshire and Kyle had written that they could not meet him in Edinburgh.

Wishart bade goodbye to Hugh Douglas, John Knox, and others. Knox, who had assisted Wishart ever since he had come into the area of Lothian, begged to accompany Wishart, but the reformer forbade it, telling Knox that one was sufficient for a sacrifice. Knox and Wishart never met again. The two-handed sword was taken from John Knox, who returned with Hugh Douglas to Longniddry. Wishart thus left Haddington on foot in heavy frost over bad roads for Ormiston, which was only about six miles away. Accompanying the reformer were John Cockburn (Wishart's host, who was from Ormiston); John Sandilands the Younger of Calder, Cockburn's brother-in-law; and Alexander Crichton of Brunstone.²²

The provincial synod met in Edinburgh on January 13, 1546. Beaton quickly adjourned the meeting until after Easter, but not before promising to silence a certain heretic (no doubt it was Wishart). The cardinal persuaded the Scottish regent, Arran, to have soldiers apprehend Wishart so he could be prosecuted as a heretic. Beaton next had the Earl of Bothwell, who was sheriff of Haddingtonshire, to accompany him to Elphinstone Tower with five hundred armed men. (It is significant that as many as five hundred men were used. This probably means that Wishart had a considerable number of followers.) Wishart's arrival in Ormiston had quickly become known, and Beaton and Bothwell planned to capture him. Before midnight on January 16, 1546, noises came from outside the house of Ormiston. It was

George Wishart: His Role in the Scottish Reformation Movement

the Earl of Bothwell and a contingent of troops. Bothwell called for Cockburn, lord of Ormiston, saying that Arran and Beaton were coming. The cardinal was at that moment at Elphinstone, only a mile from Ormiston. Cockburn was ordered to surrender himself and his guests. Bothwell gave Cockburn a solemn promise to protect Wishart, even against the cardinal.²³

Wishart's friends were relieved to hear Bothwell's promise of safety for the reformer, and they vowed to serve Bothwell. They all shook hands and Wishart left with the earl. Despite his pledge, Bothwell immediately took Wishart to Elphinstone Tower, where Cardinal Beaton awaited him. Regarding those who had harbored Wishart, Beaton ordered a force back to apprehend John Sandilands the Younger of Calder and Alexander Crichton of Brunstone, who were both with John Cockburn, lord of Ormiston. Cockburn invited the leaders of the military force to have a drink and feed their horses while he and the others prepared to leave with them. Crichton used the opportunity to make a quick escape, but Cockburn and Sandilands were captured and imprisoned in Edinburgh Castle. Cockburn managed to escape over the wall of the castle, but Sandilands remained there until he paid Beaton a fee for his release.²⁴

Transporting Wishart to Edinburgh briefly, the Earl of Bothwell soon brought him back to Haddingtonshire and lodged him in the Bothwell Castle of Hailes. After the queen regent, Mary of Guise-Lorraine, promised to renew her favor toward Bothwell and the cardinal offered money, Bothwell was persuaded to bring Wishart to Edinburgh Castle. Here the reformer was kept only a few days, because Beaton, with the consent of Arran, moved Wishart to his own castle of St. Andrews in late January and imprisoned him in the sea tower there where he remained until being burned on March 1, 1546.²⁵

While Wishart awaited trial, there occurred a meeting of the queen, regent, and cardinal with a number of nobles on February 26, 1546 at St. Johnstoun. There, according to the *Pittscottie Chronicle*, Arran, the cardinal, and Archibald Campbell, fourth Earl of Argyle, who was then justice of Scotland, condemned to death four men and hanged them "because they eat an rostit guse in Lentroun." Also, they condemned a young woman to death and drowned her "because scho wald not pray to our Lady in hir birth and deliverance of her birth" These verdicts were given by the Earl of Argyle, with the approval of Arran and Beaton.²⁶

Cardinal Beaton had summoned the Scottish clergy, including bishops, abbots, priors, deans, friars, and priests, to St. Andrews so they could witness the trial of the Rev. George Wishart. Beaton had some potential obstacles to Wishart's execution. For one thing, approval for a death sentence was supposed to have Arran's consent. Sir David Hamilton of Preston, however, vigorously protested to Arran about Beaton's plan to kill the reformer, pointing among other things to the cardinal's ambition. He said that the reformer had only preached what was in the scriptures and those who accused him were relying on doctrines not clearly taught in the Bible. Arran, consequently, wrote to Cardinal Beaton, asking that the examination of Wishart be delayed until they could discuss the matter further, because at the moment the regent would not agree to the execution plan of Beaton. Despite the regent's instructions, Beaton, with the agreement of his clergy, refused to delay the trial. Although aware of Arran's

reluctance, the cardinal felt sufficiently confident to proceed, anyway. Another possible problem for Beaton was to persuade Archbishop Gavin Dunbar of Glasgow to attend the trial. Dunbar and Beaton had a serious dispute in Glasgow over precedence of entry into the cathedral church there on June 4, 1545, and it was not at all certain that Dunbar would cooperate with Beaton thereafter. They did so firmly agree on the idea of suppression of religious reformers, however, that Dunbar decided to participate in the trial. This decision gave Cardinal Beaton much additional support for his plan to execute Wishart.²⁷

John Winram, sub-prior of the abbey at St. Andrews and doctor of theology, presented to Wishart on February 27, 1546 an order to stand trial for heresy. The next day the bishops met with Beaton in his cathedral to begin the proceedings. The guns of the castle were prepared and manned against any attempt to rescue the reformer. On the morning of the trial the bishops were escorted into the cathedral by Beaton's retainers, who were armed with spears, axes, and other weapons. Wishart was released from irons and taken into the cathedral by the captain of the castle and one hundred armed men, according to Foxe. Winram, the sub-prior, was assigned by Beaton to present a sermon on the "Parable of the Sower," taken from the thirteenth chapter of Matthew. He depicted scripture as the good seed and heresy as the evil seed. It was a rather mild sermon, exhorting all to live the Christian life and make scripture the test of true doctrine. He said that just as a goldsmith has a test for true metal, so should scripture be the test for heresy, and heretics should be put down by the civil authorities. Winram himself had actually been suspected of having sympathy for the Reformed faith; eventually he converted to Protestantism, joining John Knox and others in preparing the Confession of Faith and the First Book of Discipline. At the close of Winram's sermon, Wishart was asked to go to the pulpit and there answer several articles of accusation. John Lauder, a priest and member of the priory who had studied at St. Andrews, and Andrew Oliphant served as the principal accusers of Wishart.²⁸

TRIAL AND EXECUTION

Proceedings from the trial of Wishart actually give us more of the specific doctrines he taught than any other available data for this phase of his life. The three basic sources for this trial, and indeed for his entire life, are all Protestant sources. They are the *Pittscottie Chronicle*, Foxe's *Book of Martyrs*, and John Knox's *History of the Church of Scotland*. Stripped of their excessive praise of Wishart and condemnation of all those who tried him, however, these sources do tell us the basic facts of Wishart's preaching and doctrines.

John Lauder stood next to Wishart and read approximately eighteen charges. Wishart was asked to answer these charges. The reformer knelt briefly, prayed, and then asked to be heard so that all could know exactly what he had taught.²⁹ He then spoke:

First and cheeflie since the time I came into this Realm I taught nothing, but the ten commandentes of God; the twelve Articles of the fayth and the prayer of the Lord in the mother tongue. Moreover in Dundee I taught the Epistle of Sainct Paule to the Romaines.³⁰

George Wishart: His Role in the Scottish Reformation Movement

Lauder answered as follows: "Thou sed sowe thou heretyke runnagate, tratour and theefe, It was not lawful for thee to preach, thou hast taken the power at thyne owne hande, without any authoritie of the Church."³¹ During a brief debate over whether to allow Wishart to answer the charges, the reformer requested that the Earl of Arran, regent of Scotland, hear his case. John Lauder asked if the exalted Beaton, who was archbishop of St. Andrews, primate, papal legate, and chancellor of Scotland, among other titles, was not adequate to judge the case. Wishart answered, "I refuse not my lord cardinal but I desire the word of God to be my judge and the temporal estate with some of your lordships my auditors because I am here my lord governor's prisoner."³² After some further discussion, it was decided to read the charges again and allow Wishart to answer each one.

Charged with preaching in Dundee after the governor had ordered him to desist, Wishart answered that the Book of Acts teaches one to resist the threats of men against preaching the gospel. "Therefore it is written we shall rather obey God the man." Lauder read the second article: "Thou false hereticke did say, that a priest standing at the altar saying masse was like a fox wagging his taile in Julie." Wishart denied this, affirming that his statement was that outward ceremony without inward changing of the heart was "nought else but the plaing of an ape, and not the trew serving of God. For God is a secrete searcher of mens hartes." Next accused of denying that there were seven sacraments, he replied that he had never taught a precise number of sacraments, "whether there be seven or eleven, fo many as are instituted by Christ and are shoven to us by the Gospel I professe openly."³³ (Wishart apparently did agree with the Lutheran and Zwinglian position that there were only two sacraments, baptism and the eucharist or communion.)

The fourth article was read: "Thou fallen hereticke thou has openly taught that auriculare confession is not a blessed Sacrament, and thou sayest that we should onlie confesse us to god, and to no priest." Wishart agreed that he had said this, stating that confession to a priest is not taught in scripture to be a sacrament, and yet there are many teachings in scripture that we should confess our sins to God. This answer disturbed many of the prelates. The fifth article charged the reformer with saying it is necessary for every person to understand his baptism. Wishart replied that people should indeed know what they promise when infants are baptized. (He indicated here that he did have some question concerning the procedure and purpose of baptizing infants.) The sixth accusation was that Wishart had denied the doctrine of transubstantiation. His subtle reply, however, was that he had simply related to his congregations a discussion he had with a Jew while sailing on the Rhine. According to Wishart, the Jew had stated the Jewish belief that "it is forbidden by the Law to faine anie kind of imagery of things in heaven above, or in the earth beneath, or in the sea under the earth: but one God only to honour. But your [Christian] Sanctuaries and churches are full of idolls." Also, the Jew complained that "a peace of bread baked upon the ashes ye adore and worship: and say that it is your God." Wishart said, "I have rehearsed here but the sayinges of a Jewe, which I never affirmed to be true."³⁴

In the seventh and eighth articles, Lauder claimed that Wishart had rejected extreme unction and the religious value of holy water. The re-

former denied that he had taught anything about extreme unction, but as for holy water he said he would accept it only if it is "conformable to the commandment and word of God" Article nine accused Wishart of teaching the priesthood of all believers--that is, that every individual has direct access to God through prayer without need of human intercessors, and also that he had said the pope had no more spiritual power than any other man.³⁵ Wishart answered somewhat ambiguously as follows:

My lords, but in the word of God I remember that I have read in some places of St. John and St. Peter of the which the one sayeth 'he hath made us kings and priests.' The other sayeth 'he hath made us the kingly priesthood,' which I have affirmed that any man being cunning in the word of God and the true faith of Jesus Christ to have his power given him from God and not by the power and violence of men³⁶

The bishops laughed aloud when he spoke these words.

Accused in the tenth article of denying free will, he answered that "as manie as beleeeve not in Christ Jesus, they are bonde servuants of sinne: He that sinneth is bound to sinne." (Here he implies that bondage to sin is a form of bondage of the will.) Lauder next charged that the reformer had taught "It is as lawful to eat flesh upon Friday, as on Sunday." Wishart replied, "I have read in the Epistles of S. Paule, that who is cleane, unto them all things are cleane; of the contrary, to the filthy . . . all things are unclean." He thus admitted his approval of eating meat on Friday. The bishops and others present promptly agreed that he spoke blasphemy. For the twelfth charge, Lauder read as follows: "Thou false hereticke doest say, that we should not pray unto Sainctes, but to God onely, say whether thou hast said this or no"³⁷ Wishart gave his reply:

. . . there are two things worthie of note. The one is certaine, and the other uncertaine. It is found plainely and certaine in Scriptures, that we should worship and honour the Lorde God with all thine heart. But as for praying to, and honouring of Sainctes, there is great doubt amongst manie, whether they heare or no, invocation made unto them. Therefore I exhorted all men equallie in my doctrine, that they should leave the unsure way, and followe the way which was taught us by our maister Christ.³⁸

The next accusation was that Wishart had denied the existence of purgatory. His answer was as follows: "I have oft read over the Bible, and yet such a term found I never, nor yet any place of Scripture applicable thereunto. Therefore I was ashamed ever to teach that thing which I could not find in the Scripture."³⁹ (Once again Wishart indicated his belief that scripture alone was the sole source of religious doctrine.) Wishart next responded regarding clerical celibacy. He said it was wrong to take vows of chastity and celibacy and then take on concubines.⁴⁰ (Apparently,

he had attacked enforced clerical celibacy, as had nearly all of the Protestant reformers. Regarding concubines, Cardinal Beaton himself was guilty, as was evidenced by his having at least eight illegitimate children.)

Replying to the remaining charges, the reformer said proceedings of church councils were acceptable *if* their pronouncements conformed to scripture. He denied that he had preached against the building of costly church buildings, or that he had condemned fasting.⁴¹ Finally, Wishart denied teaching that man's soul shall sleep until the day of judgement and not attain immortal status until then.⁴² After hearing all the charges and replies, the bishops condemned Wishart to be burned. Cardinal Beaton ordered gunners of the castle to stand ready with all their ordnance in case Wishart's followers might attempt a rescue. Wishart was asked to recant what he had preached, but he refused. He was returned to the sea tower of St. Andrews Castle where he spent the night in contemplation and prayer.

The next morning Wishart agreed to see John Winram the sub-prior for a brief period. A coat was put on the reformer and pockets of gunpowder placed on the sleeves next to his body. The gallows and fire were prepared; with the martyr's hands tied behind his back, he was led by soldiers from the castle to the place of execution on March 1, 1546. When he came to the fire he briefly kneeled and prayed and stated that he did not fear to die because his soul would immediately go to be with Christ. He said that he truly forgave those who would execute him and asked Christ to forgive them.⁴³ The hangman briefly kneeled by Wishart and asked forgiveness for his part in the event. Wishart forgave him and "by--and by he was put upon the gibbet and hanged, and burnt to powder."⁴⁴ According to the *Pittscottie Chronicle*, Wishart made a prediction to the captain of the castle regarding Cardinal Beaton just before the burning. He said, "Captaine, god forgif zone man [your master] that lyis so glorieous on the wall, and within few dayis he sall ly allis schamfullie as he lyis glorieous now."⁴⁵

Knox tells us that after Wishart's martyrdom many people, some of high rank, spoke bitterly of the execution, "yea men of great byrth & estimation, and honour at open tables avowed, that the blood of the said Maister George should be revenged, or else it should cost lyfe for lyfe."⁴⁶ We do know that Cardinal Beaton retired with his mistress, Marian Ogilvy, on May 28, 1546 only to be awakened early the next morning by the entry into the castle courtyard of approximately sixteen men, some of whom had been Wishart's friends, such as John Leslie and James Melville. Some of these men entered the castle itself, stabbed Beaton to death, and hanged him out the window in what may be called the defenestration at the Castle of St. Andrews.⁴⁷ As John Leslie was about to deliver the final death stroke with his sword, he told the primate:

Repent thee of they former wicked life, but especially of the shedding of the blood of that notable servant of God Mr. George Wishart, which albeit the flame of fire hath consumed before men, yet crieth it for a vengeance upon thee, and we from God are sent to revenge it.⁴⁸

In conclusion, one may say of George Wishart that he was an educated Protestant reformer, very similar in his doctrines to the more famous John Wyclif, Martin Luther, and John Calvin. He does not seem to have been primarily moved by the political developments of the day, such as the Scottish nationalistic resentment at the strong French influence in Scotland or Henry VIII's continued meddling in Scottish affairs. If these events bothered him greatly, it is not clearly recorded. Instead, he seems to have aimed his work along religious doctrinal lines, as did Wyclif, Luther, Calvin, and others. Wishart rejected what he believed to be the medieval innovations in religious doctrine, such as purgatory, petrine theory, prayer to saints, transubstantiation, confession to priests, religious hierarchy, and so forth. Apparently, he held with the other noted sixteenth century Protestant reformers that such doctrines had unjustifiably altered the New Testament Church pattern. In any case, Wishart found fertile ground for his preaching in some of the old Lollard strongholds, such as Ayrshire, and he seems to have made some headway in various other areas such as Montrose, Dundee, and Haddington. He served as a catalyst for the Reformation thought in Scotland, building upon the earlier work of the Lollards and early sixteenth century reformers such as Patrick Hamilton, who was martyred in 1528. Also, Wishart's role in leading John Knox into a career of preaching religious reform may have been his single most important contribution to the Scottish Reformation, since Knox emerged as the principal religious leader. George Wishart thus ranks alongside Patrick Hamilton and John Knox as one of the three most significant religious leaders in the sixteenth century Scottish Reformation movement, which finally succeeded in 1560.

FOOTNOTES

¹Rev. Charles Rogers. *Memoir of George Wishart, the Scottish Martyr. With His Translation of the Helvetian Confession, and A Genealogical History of the Family of Wishart.* ("Transactions of the Royal Historical Society," Vol. IV. London: Printed for the Royal Historical Society, 1876), pp. 261-62. Hereafter cited as *Memoir of George Wishart*; Rev. John Foxe, *Fox's Book of Martyrs*. Edited by Marie Gentert King (Westwood, New Jersey: Fleming H. Revell Company, 1968), p. 157.

²*Memoir of George Wishart*, p. 263.

³Aeneas J. G. Mackay, "George Wishart," *The Dictionary of National Biography*. Edited by Sir Leslie Stephen and Sir Sidney Lee (London: Oxford University Press. Reprinted 1921-22), XXI, p. 719. Hereafter cited as D.N.B.

⁴*Memoir of George Wishart*, pp. 263-64, 267-268.

⁵Rev. Thomas Thomson, *A History of the Scottish People from the Earliest Times* (London, Glasgow, Edinburgh, and Dublin: Blackie & Son, Ltd., 1895), III, p. 67. Hereafter cited as *History of Scottish People*; *Memoir of George Wishart*, p. 264; Mackay, D.N.B., XXI, p. 719.

⁶Mackay, D.N.B., XXI, p. 720.

George Wishart: His Role in the Scottish Reformation Movement

⁷*Memoir of George Wishart*, p. 273.

⁸Thomson, *History of Scottish People*, III, p. 67.

⁹*Memoir of George Wishart*, pp. 274-75.

¹⁰*A Diurnal of Remarkable Occurrents That Have Passed Within the Country of Scotland Since the Death of King James IV Till the Year 1575*. Edited by Thomas Thomson (Edinburgh: Bannatyne Club, 1833), p. 29.

¹¹Great Britain, Public Record Office, *The Acts of the Parliaments of Scotland*. Collected by Thomas Thomson and Cosmo Innes (London: His Majesty's Stationery Office, 1814), II, p. 443.

¹²*Memoir of George Wishart*, pp. 275-77.

¹³John Knox, *The History of the Church of Scotland* (London: T. Vautrollier, 1587), pp. 101-03; *Memoir of George Wishart*, pp. 278-79.

¹⁴*Memoir of George Wishart*, pp. 279-80; Knox, *The History of the Church of Scotland*, pp. 103-04.

¹⁵Knox, *The History of the Church of Scotland*, p. 104.

¹⁶Foxe, *Book of Martyrs*, p. 157; Knox, *The History of the Church of Scotland*, pp. 104-05; *Memoir of George Wishart*, pp. 280-81.

¹⁷Knox, *The History of the Church of Scotland*, p. 105.

¹⁸*Ibid.*, p. 106.

¹⁹*Memoir of George Wishart*, p. 282; Thomson, *History of Scottish People*, III, p. 68.

²⁰Knox, *The History of the Church of Scotland*, pp. 105-07.

²¹*Memoir of George Wishart*, pp. 283-88; Knox, *The History of the Church of Scotland*, pp. 107-10.

²²Knox, *The History of the Church of Scotland*, pp. 111-13; *Memoir of George Wishart*, pp. 288-90.

²³Robert Lindesay of Pittscottie, *The Historie and Cronicles of Scotland from the Slaughtre of King James the First to the Ane Thousande Fyve Hundreith Thrie Scoir Fyftein Zeir*. Edited by Aeneas J. G. Mackay (Edinburgh, Printed for the Scottish Text Society by William Blackwood and Sons, 1899), II, p. 52. Hereafter cited as *Pittscottie Chronicle*; Knox, *The History of the Church of Scotland*, p. 113.

²⁴*Pittscottie Chronicle*, II, p. 53; Knox, *The History of the Church of Scotland*, pp. 113-16.

²⁵*Memoir of George Wishart*, pp. 294-95.

²⁶*Pittscottie Chronicle*, II, p. 53.

²⁷Knox, *The History of the Church of Scotland*, p. 117; *Pittscottie Chronicle*, II, pp. 55-56.

²⁸Foxe, *Book of Martyrs*, p. 157; *Pittscottie Chronicle*, II, pp. 56-57; Knox, *The History of the Church of Scotland*, pp. 120-21; *Memoir of George Wishart*, pp. 296-98.

²⁹Knox, *The History of the Church of Scotland*, pp. 122-23.

³⁰*Ibid.*, p. 124.

³¹*Ibid.*

³²*Pittscottie Chronicle*, II, pp. 62-63.

³³Knox, *The History of the Church of Scotland*, pp. 125-27.

³⁴*Ibid.*, pp. 127-29.

³⁵*Pittscottie Chronicle*, II, pp. 67-68.

³⁶*Ibid.*, p. 68.

³⁷Knox, *The History of the Church of Scotland*, pp. 131-33.

³⁸*Ibid.*, p. 133.

³⁹Foxe, *Book of Martyrs*, p. 161; *Pittscottie Chronicle*, II, p. 71.

⁴⁰Knox, *The History of the Church of Scotland*, p. 134.

⁴¹*Ibid.*, pp. 135-36.

⁴²Foxe, *Book of Martyrs*, p. 161.

⁴³Knox, *The History of the Church of Scotland*, pp. 137-41; Foxe, *Book of Martyrs*, pp. 161-62; *Pittscottie Chronicle*, II, pp. 74-81.

⁴⁴Foxe, *Book of Martyrs*, p. 162.

⁴⁵*Pittscottie Chronicle*, II, p. 81.

⁴⁶Knox, *The History of the Church of Scotland*, p. 141.

⁴⁷*Ibid.*, pp. 143-46; Thomson, *History of Scottish People*, III, p. 72.

⁴⁸Thomson, *History of Scottish People*, III, p. 72.

Index

INDEX

Adams, Murray	3, 214
Alkyl halides, reactions on silver sulfamate	180
Allen, Leonard G.	122
Amphibians of northeast Alabama	173
Apollo imagery, structural significance	183
Ashland Hillabee contact in Clay and Coosa Counties, nature of	187
Askew, Raymond F.	194
Asteroid, onboard attitude determination	225
Atmosphere, structure in lower troposphere and mid- stratosphere as delineated by wind profile	195
Atwood, J. L.	179
Bailey, J. Earl	224
Barnes, Jake H.	166
Bartram's <i>Oenothera grandiflora</i> , habitat and distribution in Baldwin County, Alabama	168
Bell, G. L., Jr.	181
Best, John T.	225
Biology teaching in the Southeast, status report	209
Bizzoco, Bruce D.	231
Black religious institutions during presidential recon- struction	219
Blast furnace operations with the use of Warrior Basin and Blue Creek Basin strip mine coals in metal- lurgical coke	122
Bogan, Carolyn	177
Bonfield, E. H.	142, 198
Brockman, George F.	180, 181
Bunn, Ralph H., Jr.	231
Burbank, J. H.	190
Carbonized seed foods, size changes in	232
Carmichael, Emmett B.	107, 223
Carruth, Robert T.	194
Cayman Island research project, plant distribution	193
Census, U.S., privacy	80
Chang, Kichoon	177
Chastain, E. D.	202, 204
Chickamauga Group at Birmingham, lithostratigraphy	180
Chickamauga Group near Birmingham, paleontology	181
City management, computer aided	217
Clark, Floretta G.	206
Clark, John Robert	182
Clark, Neil P.	206
Clark, Otis M., Jr.	183
Clearcutting silvicultural system	23
Climatological relationships among moisture variables	197
Cloud, Ralph M.	198
Cochis, Thomas	167, 169
Cochran, John E.	225, 229
Compost, unorthodox way for organic gardeners	107

Journal of the Alabama Academy of Science

Compressed speech, use of information rate variation	211
Confederation land policy, role of the Massachusetts delegation	94, 218
Consumer knowledge	142, 198
Cooper, Robert E.	122
Couch, Richard	206
Cosmic X-ray observations, summary of recent	41
Costes, Danice H.	167
Croker, Thomas C., Jr.	14
Crystal structure of trimethyl(quinuclidine)aluminum	179
Cultural ecology, context for the David-Goliath contest	233
Culture, patterned scandals	238
Culture shock and socialization among teachers in bicultural settings	215
Cunningham, Hugh B.	168
Daily, Freda Smith	191
Damewood, Judith C.	208
Dansby, U. Wayne	199
Davis, Grant M.	200, 289
Davis, John	200
DeBrunner, L. E.	23
Decision making process in Japanese management system	199
de Evia, José; activities in Mobile, 1780-1784	216
Dermatoglyphs, human, mathematical analysis of	171
Dickens, Steve	183
Diener, Jacquelyn M.	63, 214, 248
Dills, Gary	55
1,3-dioxolan-2-ylum and related heterocyclic cations	178
Divorce rates, analysis	221
Dixon, Carl F.	174
Drahovzal, James A.	183
<i>Drosophila melanogaster</i> , daughterless mutation, acid and alkaline phosphatase deficiency	166
<i>Drosophila melanogaster</i> , determination of how BHT causes decrease in oviposition	170
Duncan, W. Jack	201
Dycus, Donald D.	167
Eaves, Richard Glen	302
Economics in the social sciences curriculum	284
Education, uses of game theory in social science education, a humanistic perspective	9
Egrets and herons, study of reproductive mortality, Cliftonville, Mississippi	175
Eich, Joan N.	232
Electron-electron double resonance of irradiated organic single crystals	177
Ellis, Charles Michael	201
Employment, profile of un- and under-employed profes- sionals, Huntsville aerospace experience	198
Environmental surveys, tool for teaching ecology	208
Environment, chemical effects of the city of Montgomery on the Alabama River	179

Index

Equal employment opportunity provisions of 1964 Civil Rights Act vs state protective legislation for women	205
Essenwanger, Oskar M.	195
Evans, Patricia J.	202
Excavation, Indian skeleton	236
Excavations in Jerusalem of the Jewish Temple from the Roman period	235
Excavations, I-65 highway salvage	236
Family counseling, personality characteristics of students in	223
Ferguson, Patrick	9, 215
Festal honoring of the Virgin in Yucatan	232
Fields, Stanley A.	225
Filters, system function sensitivity of single component errors in approximation type filters	230
Filter tuning procedure, statistical approach to optimization of	229
Fish, bacteriological survey of freshwater fishes of the Tensaw River, Alabama	18
Fishes, freshwater, of the Bankhead National Forest in Alabama	167
Flowering herbaceous dicots of spring in northeast Alabama	169
Foreign (Korean) student adjustments to the USA	235
French, Frances	214
Fusion power, light of the future	194
Futato, Eugene M.	232
Gainesville salvage 71, features encountered at the two primary excavation sites 1Gr1 and 1Gr5	231
Gazzier, Conrad A.	184
Geology, quaternary, of the Alabama River area	188
German working class movement and the Austro-Prussian War of 1866	111, 217
Gibson, Faison P.	196
Gilbert, Oscar E., Jr.	184
Gilbreath, Glenn H.	91
Gonce, Mary Nell	208
Griffitts, F. A.	179
Hanby, Kendal	185
Hansen, Asael T.	233
Harding's Birmingham Address, President Warren G.	63
Harris, Catherine T.	32
Hartwig, Chester W.	216
Harwell, Kenneth E.	225
Haynes, Charles D.	226, 259
Hazlegrove, Leven S.	176
Heifner, Roy L., Jr.	227
Helfin, Senator; Presidential campaign of 1938 in Alabama	220
Henry, H. R.	228
Hill, Mary Cassandra	234
Himes, Samuel H., Jr.	142
Hinton, John H., Jr.	192

Journal of the Alabama Academy of Science

Holley, William H., Jr.	202
Holmes, Jack D. L.	216
Holograms, computer generated digital holography and applications	227
Horne, Verda	168
Howell, William M.	167
Hurd, John C.	168
Ignizio, James P.	217
Immunoglobulin M, physiochemical characterization of a macromolecular product obtained by tryptic degradation	176
Indian ancestry, sex of the original Amerind ancestor of part-Indian students at the University of Alabama in Tuscaloosa	237
Industry structures and logistics strategies	289
Iron, possible depositional mechanisms in the Red Mountain Formation	184
Isbell, Raymond	177
Isotope effect on the U-band in cesium halides	197
Johnson, Sterling K.	18
Joines, Karen	234
Kerr, J.	229, 230
Keynes, a closer look at	204
Keynes vs Pigou, expectations	202
Kilburn, John Wilson	192
Kispert, Lowell	177
Knossos, unplundered treasure of Crete	235
Knotts, Carl R.	209
Kohout, F. A.	228
Landers, Kenneth E.	167, 169
Land-use applications from space research, environmental	125
Land use of Marshall County, determined by aerial photography	192
Lazear, Jesse William	223
Lee, Wonhee	235
Life insurance, attitudes of students at the University of Alabama in Tuscaloosa	200
Linder, Susan	211
Liu, C. K.	228
Mabry, Helen M.	235
Maehl, William H.	111, 217
Magnetic field, effects on embryonic development	172
Managerial decision making, judgement	201
Manger, Elizabeth	155
Manger, Martin C.	155
Marrin, Al	229
Martin, Elizabeth F.	209
Marx, Carolyn	235
Mayer, M. L.	203
McCarl, Henry N.	159
McCay, T. Dwayne	225
McCreary, John R.	94, 218
McManus, Samuel P.	178

Index

Meroney, Nancy	185
Meteors, atmospheric heating of	225
Mineralogy of Alabama bentonites	189
Mining and society, study of the interaction in an urban environment	159
Missile attitudes and trajectories, effects of blast penetrations	229
Mollusca, freshwater, of western Lee County, Alabama	168
Moore, Carl C.	204
Mooreville-Blufftown Formations, southeast Alabama, delineation of lithofacies within	185
Morley, S. G., anthropologist	234
Moser, Paul H.	186, 190
Mudcrack systems and their origin	183
Myers, John B.	219
Neathery, Thornton L.	183, 186
Neutron scattering measurements	198
New Deal agencies, influences on education in the U.S. prior to 1944	214, 248
Nomograph for testing proportions when normal approxi- mations are appropriate	91
Nuclear preionization of high pressure gas lasers	196
Nuclear reactions, kinematics of	194
Oakley, Carey B.	236
Occupational work structures, occupational values, and use of leisure	3
Oliver, Robert	170
Opossum, telemetered thermal responses	55
Osborne, Donald Lee	236
Osterlund, Marilyn	192
Oysters, ecology of being affected by changing patterns of sedimentation, Little Dauphin Island, Alabama	184
Padgett, Mary L.	171
Paludan, Charles T. N.	125
Paragenesis in Jeff Price Mine, Cave-in-rock District, Illinois	182
Parasitism, blood changes in rabbits infected with <i>Trichostrongylus affinis</i>	174
Parikh, U.	229
Park, James W.	278
Partial molal volumes, a study of	177
Pearson, Jim	179
Personnel practices in Alabama hospitals	202
Pharris, Hugh D.	211
Physical science for non-science students	213
Pierce, Kenneth	193
Pine, comparison of yellow-poplar, loblolly, and Virginia pine	193
Pine, longleaf, Alabama	14
Pinson Cave (1Je20), analysis of dental material from	231
Politics and culture, comparative analysis of mavericks and conformists in the U.S. House of Representatives 1836-1860	221

Journal of the Alabama Academy of Science

Pompeii	237
Reagan, Hugh D.	220
Retail structure of Great Britain, predictions	203
Reynolds, John M.	225
Reynolds, John W.	187
Riggsby, Dutchie S.	210
Riggsby, Ernest D.	211
Riverton-Rose Trail	191
Robinson, E. L.	196
Rock movement of the Pottsville, northern Cullman County	186
Rodriguez-Kabana, R.	174
Russell, John R., III	172
Sanford, L. G.	173
Scarborough, Leon	185
Schrohenloher, Ralph E.	176
Science, sense appeal	210
Searcy, Margaret Z.	237
Sebastian, Glenn R.	193
SEEK-IT implications for under-achievers	212
Shannon, Robert E.	220
Sharma, Prakash C.	211, 221
Shatas, R. A.	197
Shell, William B.	212
Sherling, Dorothy N.	204
Shields, Johanna N.	221
Shotts, Reynold Q.	230
Shrubs, cultivated flowering, of northeast Alabama	167
Silent majority, dynamics of informal power	214
Smalley, Glendon W.	193
Smith, Larry R.	177
Smith, Roger E.	174
Smith, W. Everett	189
Social change and continuity, University of Alabama campus in the sixties	222
Socialist rent theory and agricultural reform in eastern Europe	201
Socioeconomic impact analysis, application of a dynamic simulation model to	204
Socio-economic progress, measurement of	220
Sociology, meaning of radical sociology	216
Soil trehalase activity, seasonal changes in	174
Solid waste collection problems	223
Solid waste disposal, a community crisis	185
Spritzer, Allan D.	205
Stability of cell inactivation due to repeated radiation exposures, parametric study	228
Steele, H. Ellsworth	80
Stewart, Dorathy Anne	197
Stratigraphy of the Hillabee Chlorite Schist in the new Piedmont stratigraphy	186
Stream velocity, effect on concentration of some heavy metals during flowing slugs in the reservoirs of the Black Warrior River	176
Stuart, Jeanne J.	174

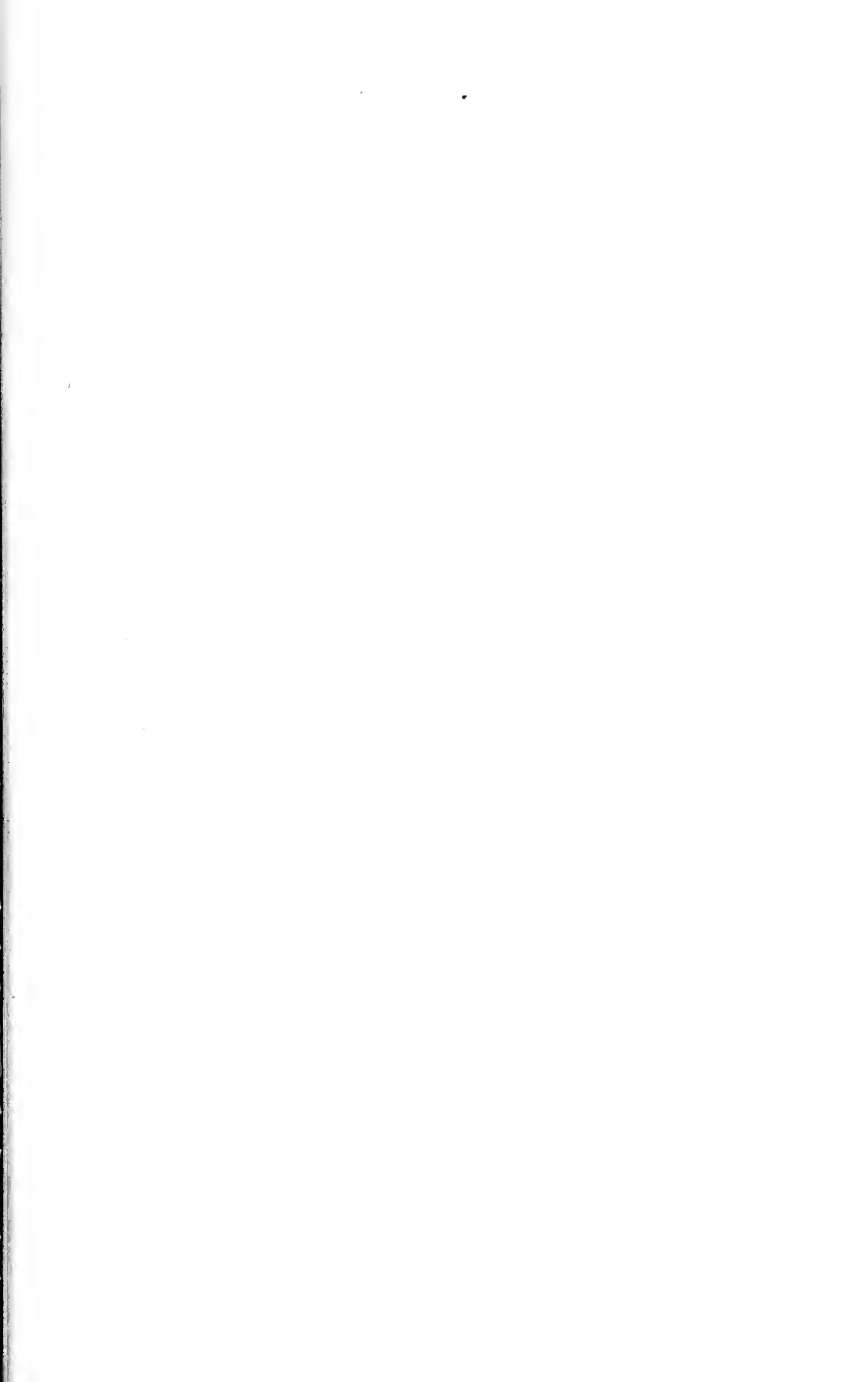
Index

Summer institutes, help for the secondary science teachers of Alabama	155
Summerour, Charles W., III	175
Sutherland, Dixon	237
Sutley, Caterina C.	222
Systems approach to science instruction, effect on attitude	206
Szabo, Michael W.	188
Tanton, G. A.	197
Taylor, Ronald S.	189
Teacher awareness toward impact of failure on elementary school children	211
Teachers, preparation of junior high school science teachers	208
Teaching by contract system, human anatomy and physiology	214
Teaching genetics laboratory by contract method	206
Testing, oral testing for non-readers in science	209
Timber harvesting, occupational training	192
Tomaspidini (Insecta: Homoptera: Cercopidae), description of three new genera and three new species	167
Tombigbee sand at Montgomery, environmental significance of	189
Trucking, economic significance of concentration in the regulated intercity trucking industry	200
Unisor, University isotope separator at Oak Ridge	196
Universe, living, a hypothesis	192
Vacuum X-ray reflectometer	225
Vanlier, Kenneth E.	190
Van Matre, Joseph G.	91
Van Sise, Kenneth E.	284
Volcano, La Soufriere, Guadeloupe	183
Wage and price controls, an early attempt: Diocletian's Edict of 301 A.D.	278
Ward, Charlotte R.	213
Waste collection problems, solid waste	146
Waste disposal of liquids in deep saline aquifers	228
Waste disposal of liquids by deep-well methods	226, 259
Waste glass as a component in lightweight aggregate	230
Waste water treatment process, optimal feedback control	224
Waterfowl propagation and release techniques, development and testing	190
Water producing cavities in karstic limestone, method for determining size and shape	190
Watson, J. E.	166, 170, 171
Weathers, G.	230
Weber, Max; patterns of religious and political involvement	32
Wells, Sue	179
Werkheiser, Arthur H.	198
White, Henry E., Jr.	223
Whited, Rodney	169
Whitt, C. D.	179
Williams, Ernest H., Jr.	18
Williams, George, Jr.	214
Williams, Louis G.	176
Wilson, Robert M.	41

Journal of the Alabama Academy of Science

Winston County Bluff Shelter, excavations	234
Wishart, George: his role in the Scottish Reformation movement	302
Wyskida, Richard M.	146, 223
X-ray fluorescence detector for element analysis and organ scanning	196
Zeannah, Shelby K.	238
Ziegler, P. F.	180





AMNH LIBRARY



100232700